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PROCEEDINGS OF THE 1991 NSW THERMAL WORKSHOP

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This technical report has been reviewed by the NMRI scientific and public affairs staff and is approved for publication. It is releasable to the National Technical Information Service where it will be available to the general public, including foreign nations.

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PREFACE

Thermal stress can have a significant impact on Naval Special Warfare (NSW) personnel during the conduct of their missions. The Naval Special Warfare Command (NAVSPECWARCOM) has sponsored many research and development efforts. A need was identified to standardize thermal and performance measures used in many laboratory and field studies. Standardized measurements will provide SEAL operators with information useful in operational planning, and facilitate comparison of data obtained by various R&D laboratories.

COMNAVSPECWARCOM Task 1-90 was developed to address the issue of standard thermal and performance indices related to NSW mission effectiveness. Phase I of the task involved conducting a Thermal Workshop where operational and research personnel could discuss relevant thermal problems associated with SEAL diving operations. Also standard indices would be developed for use by all research laboratories and incorporated into a reporting format useful to mission planners.

The workshop was organized by the Naval Medical Reserarch Institute and held 16-17 September 1991 at the Virginia Beach Resort Hotel in Virginia Beach, VA. The meeting location lessened the travel requirements for NSW units in the Little Creek, VA area. All SEAL and SDV Teams, the NSW Development Group, the NSW Training Center, NAVSEA 06-Z, NAVSPECWARCOM, and each Group command were invited to send representatives. Each operational unit was asked to present a 10-minute briefing on their particular thermal concerns. All information was to be unclassified. R&D representatives were invited from the Naval Medical Research Institute, Naval Health Research Center, Navy Experimental Diving Unit, and the Naval Coastal Systems Center. A total of 31 persons attended; their names are included in Annex A. Eight operational units or commands presented their thermal and performance issues.

Each session in the workshop was recorded and transcribed by the American Federal Reporting Services of Bristol, TN. This service, and the subsequent editorial assistance, were provided through the Undersea and Hyperbaric Medical Society. Special thanks for their assistance are extended to Linda Hanson of the Virginia Beach Resort Hotel, Elaine Ferguson of American Federal Reporting Services, and Jane Dunne and Ann Barker of the Undersea and Hyperbaric Medical Society.

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INTRODUCTION

DR. DOUBT: My name is Tom Doubt from Naval Medical Research Institute (NMRI), the host of this Naval Special Warfare (NSW) Thermal Workshop.

I'd like to cover a couple of administrative matters before we get started, the first of which is that all of the open sessions are being recorded. The purpose of the recordings is to develop a proceedings from this workshop which will be published and distributed to all the NSW units and commands and all of the R&D Labs involved in biomedical research.

To that end, I would ask you when you ask a question or give a presentation, to identify yourself and your command or your unit, at least the first time; this would help the transcriber, Elaine Ferguson, from American Federal Reporting. It will be helpful when we get the typed transcriptions to know who said what. If there's a question we can get back to you and say, "What did you mean?"

In the back of the room are a number of reprints and reports from the Naval Health Research Center (NHRC) and NMRI on some of the related research that has already been done. During the break or at some time during the conference, you can go back there and peruse those reports. You're free to take a copy. If there is only one report, then see a representative from NHRC or NMRI, he'll put your name on a list, and send you that report.

Now, what I'd like to do is just briefly go around the room and have people introduce themselves by name and command.

[See Annex A for List of Attendees]

DR. DOUBT: Thank you. In your manilla folders you have the agenda.

[See Table of Contents for Agenda]

We may need to adjust that slightly as we go. If you have a particular issue to raise in one of those sessions, see one of the people listed in parentheses who will be directing that session. If there are administrative matters related to the conference, see me. Without further ado, I turn it over to Commander Frank Butler.

WELCOMING REMARKS

CDR BUTLER: I would like to welcome everybody this morning and thank you for coming. I'd also like to congratulate Dr. Doubt on putting this together on a fairly short notice. I want to begin my remarks by outlining briefly what we hope to accomplish here.

Even though it was spelled out pretty clearly in Dr. Doubt's preliminary flyer, it's very important to emphasize that the Naval Special Warfare Command is undertaking an aggressive thermal protection program. In doing so, we've got two primary goals; number one, we want to make sure that our operators have adequate thermal protection under the worst-case scenario; and number two, we want to make sure that we provide the operators with enough data so that they can make well-informed thermal protection choices under the entire spectrum of thermal conditions; 65°F water can chill you down very effectively; it doesn't have to be 40°F to cause hypothermia.

It's very important for me to emphasize that we're not here to try to develop a NSW thermal protection plan in the next two days. That's not our charter. That's been done. Many of the people here in the room have been working hard on that for the past several years. Let's review briefly some of the projects that are currently planned or underway. First, we have a project to evaluate thermal protection in current NSW operating scenarios. This is going to be done in FY92 at NHRC.

Number two, radio frequency wave warming techniques. We're going to be looking at this innovative approach to see if it helps us reduce the energy cost of active heating. That's being done at the Naval Aerospace Medical Research Laboratory (NAMRL).

Number three is factors affecting performance in cold water immersions. It's being done at NMRI in FY 92.

Number four, a thermal garment comparison study which is currently in the planning stages, but will probably be undertaken in FY-93.

Number five, development of the diver active thermal protection system which is being coordinated through Naval Sea Systems Command (NAVSEA) and performed at NCSC in Panama City.

Number six, thermal protection garment selection guidelines which are being done by Drs. Weinberg and Thalmann at NMRI.

Number seven, active warming methods for extremities, also done at NMRI by Dr. Doubt and Dr. Weinberg.

Number eight, effects of cold immersion on performance in SDV operations which is being done at NHRC.

We're going to be discussing all of these projects in Panama City at the R&D conference in November. If we need to add to this program at that time, then we will. All the commands will hopefully be represented and we will address additional needs as they come up.

The primary focus of this workshop is to tie all of these projects together. Specifically, we're going to support NSW Task Bio-Medical R&D Task 1-90, entitled, "Development of Standard Thermal Protection Indices." The concept of standard thermal protection indices refers to a standardized method of collecting and reporting data in all of these various thermal studies. In doing this, we're basically shooting for three objectives.

Number one, we want to establish a consensus on a standard set of data that is going to be collected in each of these various thermal studies. This will provide us a common denominator to compare all these different thermal studies from all the different laboratories, and be working with apples and apples in trying to compare the results of these different studies.

Number two, we want to incorporate measurements of NSW mission-related performance as a key consideration in determining the adequacy of thermal protection. As a community, NSW has to go beyond a concept that adequate thermal protection has been achieved if nobody dies of hypothermia on the mission. We have to look at additional questions such as "Can the patrol leader think and reason effectively?" Can the operators communicate well or is their speech slow, slurred, hard to understand? Can the operators shoot effectively or are they shivering so hard that they're spraying 7.62 all over the landscape?

Number three, we've got to determine an optimal reporting format so that the data obtained in the NSW-sponsored thermal studies will be available to NSW mission planners for routine operational use. This is where you guys wearing the Budweiser, who come from line commands, are crucial to this conference. You are the main players here and I want you to be aggressive in speaking up. If researchers are talking about something you don't understand, then it's guaranteed that all the guys like you out in the fleet aren't going to understand it two years from now when the reports are published. So, speak up.

Let me illustrate what I'm saying. There's a difference between these thermal studies and other physiologic studies. When Dr. Thalmann comes up with a new decompression table, and you go out on a dive, you've got a Master Diver sitting there saying the table says you've got to decompress 72 minutes, you're going to decompress 72 minutes. It's something that's written in stone and is not an operational decision for the mission planners. It's different with thermal protection.

Thermal protection provides the mission planners with a range of options to make a well-informed choice in picking which thermal garment and what type of thermal protection they need. Our thermal researchers' job is to do whatever is necessary to help our mission planners make the right choice in thermal protection.

If we do all of these studies and 4 years later the information is not relayed to our operational people—to our mission planners, then we haven't done our job here. We have a lot of talent here, a lot of different perspectives. It's inevitable that in presenting our

experiences and opinions that we're going to get off on some tangents. Drs. Doubt and Curley will be using the gavel liberally if necessary to help us to keep our focus in this workshop. Let's all support their efforts and do the best job we can for the community in the next few days.

OVERVIEW OF WORKSHOP

DR. DOUBT: Thank you, Frank. I wanted to make a few additional comments about the overview and the objectives of the workshop. It's clear that with the expanded effort that NSW is now putting into its R&D effort, standard measures between laboratories are essential to compare the effectiveness of performance tests or thermal protection garments. Apples have to be apples.

A centralized data base to translate the reports is essential because most line operators do not want to know what the heat flux is from your forearm. They don't care if its 25 watts per square meter or if it's 50 watts per square meter. What they care about is whether they are going to get too cold to be functional. So, we need to translate these reports. If you pick up a report, you've got 20 or 30 pages of information to go through to get to a bottom line. That bottom line may be only one sentence. Translation of that sentence, I think, is important to the NSW operators.

Our task, as Frank mentioned, is to use this workshop as a starting point to look at the standard indices; to get the input from the operators; and then, in phase two, develop those standards that are useful for the operators.

We want to come away from this workshop with a series of recommendations to use as the starting point for these standard thermal protection indices. In addition, we need to develop a reporting format and a centralized data base that can be used to disseminate the information. Remember that this is a start, this is mod-0.

Next year, some of the indices that we agree upon this year may turn out to be irrelevant to operational needs or are not easily translated for mission planning.

The published proceedings of this workshop will highlight the problems identified by various units and summarize recommendations and standard measures that we agree upon. Its distribution will be to all NSW units and all commands and R&D laboratories. The proceedings will document our initial approach to address these issues.

Our initial session is to hear the input from NSW operators. You folks know what the problems are in the field. You know it much better than anyone in any of the R&D labs. Once the problems are stated we can then develop focused discussions. I use the term "focused discussions" to mean that we don't want to talk about whether a dry suit is better than a wet suit. What we want to talk about are the measures to determine whether those are

better. Likewise, we don't want to talk about task performance in terms of whether one fin is better than another. We want to look at the measures that will define how well the fins work.

We don't want to digress into minute details of how you take these measurements. If we agree that we're going to measure a finger temperature, we don't need to talk about whether to use a YSI sensor or a thermal couple. We want to talk about the measure itself.

Keep in mind that any measure should always translate, directly or indirectly, to something that the operators can use. If it's the actual value of the temperature, fine; if it's something else, then we need to focus on what variable is useful.

These are working sessions. There are no scientific presentations from any of the R&D labs. They are working sessions in the sense of establishing dialogue between the operators and the R&D labs. You folks in the field will know who's in the lab doing the measures and collecting the data. People collecting the data will know who's in the field actually trying to make something work.

Our approach to this workshop is that there are no questions that are too stupid; there are no concerns that will not be addressed. Everyone has to have an opinion, but the consensus will develop whether we accept that opinion as a working measure.

Our agenda will not discuss who's going to do the work, who's going to get the money, or what NSW units are going to be involved in field research. We must stay focused in order to achieve the objectives of this workshop.

If someone has some information that they would like to share with this workshop that they do not want recorded because they consider it sensitive information, we have a time set aside where we will not be recording. That's to facilitate direct exchange of information that may be useful in consolidating our indices.

The schedule itself, particularly for the morning sessions, is not hard and fast. Presentations are scheduled for 10 minutes. If it takes 12 minutes and there's 7 minutes of discussion, that's fine. If it takes you much longer, then you haven't thought about what you're saying and we will pull the plug so we can reasonably keep on schedule.

Next, Commander Mike Curley from NMRI is going to help focus attention on some of the thermal problems and how they affect your performance.

REVIEW OF THERMAL PROBLEMS

CDR CURLEY: Good morning. I was asked by an unnamed senior officer to summarize more than 10,000 thermal and performance studies in 10 minutes. I was able to

negotiate 15 minutes. The purpose of this brief is to give us a basic common ground so we're speaking the same language about performance physiology. As you go through this with me, you'll see there are "fill in the blanks," so that the key points are being emphasized and I need your participation.

OVERVIEW OF THERMAL PROBLEMS AND PERFORMANCE

TEMPERATURE CONTROL

Man, as a warm-blooded animal, is able to maintain his body temperature within 1° F variation under normal environmental conditions. Normal internal body temperature is *37* °C; above 45 °C or below *25* °C, d*eath* will occur.

Heat:

- Production occurs by m*etabolism*, which is the burning of fuel in the body's cells
- Distribution is accomplished by the b*lood circulation* system
- Loss occurs by
  - * r*espiration*
  - * evaporation of s*weat*
  - * radiation and c*onduction* from skin
- Regulation is controlled by the body's *thermostat*, a nerve center in the brain called the h*ypothalamus*. The hypothalamus acts basically in two ways:

1. It senses thermal changes as discomfort, leading to b*ehavioral* changes.
2. It sets off a series of functional adjustments in the body termed a*utonomic* processes.
   - * in heat, sweating occurs and there is increased blood circulation to the body's surface;
   - * in cold, shivering and non-shivering forms of heat generation occur. The body maintains temperature by striking a b*alance* between heat generation and dissipation.

PERFORMANCE

Performance can be defined in several ways:

- a manner of reacting to a stimulus
- the execution of an action
- the emittance of a behavior

For this discussion, performance will be considered to be a v*oluntary*, as opposed to reflexive, action on the part of the human being.

General Observations:

Human performance deteriorates on a continuum from "shortly" to "long" before physiological limits have been reached.
The upper thermal limit for unimpaired mental performance varies systematically with exposure time.

Factors that influence the degree and direction of the effect of thermal stress upon performance include:

- temporal factors
  * the *longer* at work, the more likely efficiency will be lowered by thermal stress
  * however, longstanding acquaintance with thermal stress may temper the impact through *acclimatization* or adaptation.
- nature of the task
  * thermal stress will affect different task categories and specific abilities *differentially*.
- motivation
  * we have assumed that *successful* resistance to stress under simulated conditions will make man more impervious to stress under *operational* conditions. The generality of this assumption needs to be examined.
  * we *assume* motivation will be higher in the "real thing", and this will mitigate the effect of thermal stress on performance. This hypothesis is unproven; perhaps untenable.
- stresses act in combination
  * additive (one + one = two)
  * synergistic (one + one = five))
  * antagonistic (one + one = zero)

CATEGORIES OF PERFORMANCE (EXAMPLES)

Category	Abilities	Tests
Mental /	coding/decoding	anagrams
Cognitive	time estimation	time reproduction
	reasoning	operations
	problem solving	arithmetic
	memory	paired-associate
	recall	digit span
	learning	repeated acquisition
	vigilance	auditory/visual
	crew coordination	navigation
	symbol processing	digit symbol
	observation	hidden patterns

Category	Abilities	Tests
Perceptual and sensory	tactile sensitivity target detection monitoring signal detection flicker fusion	Mackworth V-test
Psychomotor	manual dexterity finger dexterity reaction time tracking tapping eye-hand coordination	Pipe puzzle Purdue Pegboard simple/complex compensatory control finger oscillation rotary pursuit depth control ring and peg speed wrench
Physical proficiency	grip strength heart rate respiration rate aerobic endurance	dynamometer monitor monitor treadmill step test ergometer

COLD/WET STRESS

PHYSIOLOGICAL RESPONSES

Cold stress activates vaso*constriction* of the peripheral blood vessels with a decrease in blood flow. The skin temperature then approaches air or water temperature (within 0.5 to 2.0 °C), resulting in *increased* muscle tension, leading to increased heat production and *shivering*.

Total body heat loss:
- is at a *high* rate at first, then lessens over time, and
- *larger* people tolerate more total heat loss

Body cooling increases resting metabolism in proportion to decreases in core temperature.

Body cooling also results in a reduction of maximal heart rate and cardiac output (e.g. 10-30 bpm when Tc is 0.5 - 2.0 °C lower than normal).

The mass of the body acts as a buffer for heat loss:
* the more subcutaneous fat, the *slower* to cool

* the more the muscle mass, the *slower* to cool given equal amounts of subcutaneous fat

For a given body composition, the degree of body cooling depends on:
- air/water temperature
- *exposure* time
- individual physiological response

Cutaneous (*skin*) vasoconstriction in response to a strong cold stimulus varies across the body:
- hands and *feet* have a quick, complete constriction
- arms and *legs* have a moderate response
- *torso* gives minimal initial response
- head has a virtual *absence* of a response

Hands and feet:
- both cool *quickly*, thus limiting their later heat loss.
- become painful to move and manipulate

Hands: 20 °C - uncomfortable
15 °C - painful (functional decrements begin)
10 °C - skin is numb; pain persists due to constricted blood vessels

Feet: 23 °C - uncomfortable and cold
18 °C - painful
13 °C - numb

Respiratory heat loss
- at 1.0 ATA: heat loss due to respiration is about *10 - 20%* of metabolic heat production (mostly evaporative)
- in hyperbaric air/mixed gas: the convection component of respiratory heat loss steadily increases with density at a given gas temperature. For example, at 19 ATA Respiratory Heat Loss = *100%* of metabolic production if inspired gas is 10 °C.

If vasoconstriction and increased metabolic heat production do not conserve enough heat to maintain thermal balance, the result is a drop in Tc leading to h*ypothermia.*

Effects of Reduced Body Temperature on Body Function (Webb)

T_r, °C	Impairment of function
36-37	Cold sensations, cutaneous vasoconstriction; increase in oxygen consumption and in muscle tension by electromyogram
35-36	Sporadic shivering, suppressed by voluntary movements; bouts of shivering give way to uncontrollable shivering; oxygen consumption rises to 200-500% of resting value; *decreasing will to struggle increases risk of drowning.*

T_r, °C	Impairment of function
34-35	Amnesia and poor articulation; sensory and motor dysfunction
33-34	Clouding of consciousness, hallucinations, and delusions
32-33	Cardiac abnormalities
30-32	Motor performance grossly impaired; no response to pain; familiar persons not recognized

Cold water considerations

The thermal conductivity of water is *25* times as great as air; in water, heat is rapidly transferred from skin in the presence of a p*ositive* thermal gradient.
Cold water stress adds the following to the picture:

1. The main avenue of heat loss is c*onduction.*
2. Immersion diuresis is a temporary increase in urine flow in low water temperatures with loss of calcium, sodium, and potassium.
3. Slowing of the heart rate
4. Intense h*yper*ventilation in unprotected man
5. Respiratory heat loss
6. Increased secretions
7. Increased breathing resistance

OBSERVATIONS ON PERFORMANCE IN WET/COLD

Depending on the intensity of the thermal stress, cold can interfere with performance by:

- D*istraction* (narrowed attentional capacities); performance degradation can occur in the absence of significant physiological cooling. Tasks shown to be affected by this factor in the cold include: reaction time, target detection, navigation, problem solving, and memory recall.
- D*iscomfort*; this is due to peripheral cooling effects. Most commonly affected are: tactile sensitivity, flexibility of finger joints, and muscle strength in the arms, hands, and fingers. Tasks reflecting this degradation include finger and hand dexterity, grip strength, and hand-arm steadiness.
- D*ysfunction*. As a result of deep body cooling, the brain can be affected with degradation in memory, recall, response blocking and perseveration of inappropriate responses.

Some general observations of performance in the wet/cold environment:

- *Manual* performance is impaired when hand skin temperature drops to 13 °C and below.
- Finger dexterity *decreases* if the arm is kept cold, even if the hand is warm.
- Dexterity performance is less impaired when the hands are cooled *rapidly*, as compared to cooled slowly.

Decrements in the following tasks follow decreases in skin temperatures:

- tactile sensitivity
- grip strength
- manual movement of hands

Mental/cognitive impairment is most likely to be found in tasks requiring intense *attention* and *short*-term memory; i.e., remembering facts learned during cold exposure.

Example: Baddeley et al. found that despite a mean drop in rectal temperature of 1.3 °C for four subjects, vigilance and reasoning were not affected. However, the recall of information presented during the dive was impaired significantly.

Example: Vaughn (1975) studied 12 well-trained divers in 4- and 6-hour open-water tests of a 2-man wet submersible in 6 °C water. Depth control was unaffected; however, heading errors increased significantly over time into the dive. Further, two of four sonarmen persisted in inappropriate responses as range to the target closed. Five of the operators reported confusion and "mental driftiness". Rectal temperatures dropped an average of only 1.2 °C over the 4- and 6-hour trials.

HOT/DRY STRESS

PHYSIOLOGICAL RESPONSES

Heat stroke: we see a rapid rise in core temperature to 40-43 °C, accompanied by disorientation, delirium, struggling or convulsions, often with h*ot*, d*ry* skin.

Heat exhaustion, due to deficiencies in

* circulation
* water (dehydration)
* salt (continuous sweating with insufficient replacement of salt)
* sweat (anhidrosis) where sweating is impaired

Factors that influence efficiency of homeothermic mechanisms:

- air *speed*. If ambient temperature relative to body is higher, heating occurs; if ambient temperature lower, cooling occurs.
- humidity. If high humidity, high temperature = reduced efficiency; if high humidity, low temperature = increased efficiency through convection
- clothing
- acclimatization (heat)
- temperature of surrounding surfaces

OBSERVATIONS ON PERFORMANCE IN THE DRY / HOT

Performance of unacclimatized men more *adversely* affected by heat stress than acclimatized men

Performance is shown to be enhanced by *incentives*, increased effort, and knowledge of results.

In dry heat, *light* clothing retards the debilitating effects of heat on performance.

The more complex the task and/or the more tasks involved, the *greater* the performance decrements.

Effective temperature (ET) is an index of environmental heat which synthesizes dry bulb temperature, relative humidity, and air velocity readings. Using ET, the following results were found:

In high ambient heat , i.e. 32 °C (90 °F), performance on mental tasks *deteriorate* after 2 hours exposure for unacclimatized subjects. These mental and psychomotor tasks include:

- coding and decoding
- vigilance
- pursuit motor/tracking
- choice reaction time
- paired associate learning
- signal detection

Some human performance functions are *speeded* up when subjects are exposed to heat. These include:

- rate of tapping
- speed of counting at 1/sec rate
- estimation of time intervals
- simple reaction time

Vigilance tests show a performance improvement at elevated temperatures up to about *80* °F ET; at higher temperatures vigilance performance is impaired.

All other performance functions show little effect of temperature between the zone of *thermal* comfort and about 85 °F ET.

Above 85 °F ET, performance shows *increasing* decrements as temperature increases. Example. Epstein et al. (1980) conducted a study with the Israeli Defence Force in which men performed a video test of vigilance and shooting at a target. Performance was assessed

at ETs of 21 °C, 30 °C, and 35 °C. Their findings were:

- increasing task intensity and increasing heat load yielded a synergistic performance effect.
- psychomotor performance decreased before physiological measures (HR, sweat rate; rectal temperature) did; perhaps this is due to discomfort.
- even highly motivated subjects were affected by the heat load, especially when assigned complex tasks.

DR. DOUBT: What I want to do is start into the presentations from the various units beginning with NSW Group 1.

OPERATOR PRESENTATIONS

NSW GROUP ONE

MR. DUDINSKY: This one will be a whole lot easier. You don't have to fill in any blanks or anything. I will make it quick. I'm the Technical Advisor, NSW Group 1.

As Technical Advisor, one of my primary jobs is to evaluate equipment and evaluate equipment efficiencies for the three West Coast SEAL teams, SDV Team 1, and the Special Boat Units that are on the West Coast. To that end, I'm not going to try to speak to what the thermal deficiencies are of our operators. They're here and they can do a much better job of that than I can.

One thing I would like to say, though, is that I would be thrilled to assist anybody in the evaluation of equipment. I know that there are several things that NMRI is doing with electrically heated gloves; that NCSC is doing with the thermal electric heat pump. My purpose in life, if you will, is to assist you guys in carrying out those field evaluations. Other than that, I don't have a formal presentation. I just wanted to tell you who I was, and what I do, and I'd be happy to help you out anyway I can out at Coronado.

So, thank you.

DR. DOUBT: Does anyone have questions of John?

UNKNOWN: Did you get any feedback from the troops over in the Gulf about how that environment affected any of the protective clothing they wore?

MR. DUDINSKY: Well, in the air environment, of course, they were very hot with decontamination suits like the Mark IV suit and Mark V suit. The bottom line was that you cannot effectively operate in the chemical protective suit we've got right now for more than about 1½–2 hours. Often they would be using the suit that had both a separate top and a bottom; they would take the top off or something like that in order to stay cool, which is not

satisfactory from a standpoint of chemical protection. However, that's just the way it is at this point.

I am not aware of any problems with hot water in terms of diving over there.

DR. DOUBT: John, are you currently conducting any field evaluations apart from what the R&D labs are doing?

MR. DUDINSKY: No, not in the world of thermal protection at this point. The only thing I was aware was that Bob Weinberg was planning on coming out with the electrically heated gloves and I'd like to get into that to help in any way I can.

DR. HYDE: Did you get any kind of physiological measures on these people in the suit, or was it all subjective?

MR. DUDINSKY: It's all subjective information. Another thing to keep in mind is that you will find, from my experience with our operations in Bangor and such, the amount of time you can stay in the water is totally dependent on your motivation level. We've had guys run for 9 hours in Bangor water which is in the 30's (°F). Those guys were in pretty rough shape when they came back, although we've also seen guys go for 7 hours who came out and they were looking pretty good.

About a year and a half ago, I was out in Bangor and watched guys come out after 7 hours and their hands were cold, but other than that they were doing pretty good. They talked and acted pretty much like normal. So, a lot of this is due to, I think, the motivation factor.

DR. DOUBT: Is there a representative from Group 2?

UNKNOWN: The Chief Staff Officer Group 2, Commander Colter, had scheduled himself to be here to give the presentation, but at the last day or two was unable to make this commitment.

SEAL TEAM 3

DR. DOUBT: Then, we'll move on to SEAL Team 3.

HM2 Pappamihiel: I don't have a lot of background that you folks do. I kind of feel like a little man on the totem pole here today. But, one thing I do have is a lot of recent experience—actually going out and doing a lot of stuff that we're going to be talking about. I was over in Saudi last summer from August till March. I probably saw a range of air temperatures from 125 to 130°F to 30°F up in the mountains or toward the higher desert areas of Saudi Arabia.

At SEAL Team 3 we're working on new missions, or area of orientations over there. We probably have a greater range of varied operations than any other team. We're still going to have the "R" commitment and we're looking at anywhere from 25°F water in Alaska or off Korea, to working in Subic or in the Mideast where the water temperature can get up to 99°F. I was also over in the Persian Gulf back in '88 where I had one of my officers on a recreational dive develop heat exhaustion because he wasn't able to replace water whenever he was on his dive. Eventually, we had to put 4 liters of i.v. fluid into him.

Frequency of transitions from water to land is going to vary according to the operation and the work environment. It can be as many as half a dozen transitions depending on what you're going to be doing and where you're going to be doing it. The average diving depth for us is usually limited to about 30 or 40 feet. Most of the time it's going to be in the 20-foot level.

The average time on targets can vary with the mission depending on what kind of mission we're going to be doing. During some of the missions we had to practice for over in Saudi, we were out in the field as many as 12 hours and sometimes a lot less than that.

Thermal protection garments we had available to us: wet suits, dry suits, GoreTex and polypropolene. Over in Saudi, thermal protection garments in the winter time got to be a real problem because when we left to go in August, the last thing we were thinking about was freezing our butts off in January. It was a problem because a lot of the people who were over there had their equipment packed away somewhere where nobody tended to know where it was and our wives couldn't get to it. We were able to get some stuff sent there and it worked out okay. I had my GoreTex and my light weight polypropolene and my wool underwear. I just wore double of it instead of wearing expedition weight polypropolene which I wish I had. I was able to keep fairly warm.

The criteria for determining the selection of garments. That's going to be based on the mission requirements—what type of environment you're going to be working in and how long you're going to be out there.

The type of protection used for hands, feet, or head; for most diving operations, wet suit gloves for hand protection or mittens or gloves with wool liners for field operations. Polypropolene liners are also available for hand protection. Protection during diving operations is the wet-suit gloves and wool or polypropolene cap for field operations.

Foot protection during diving operations—usually wet-suit booties or during field operations, Danner boots with wool or polypropolene socks.

Specific problems encountered were adequacy of thermal protection with booties or gloves during diving operations, during cold water operations. Often the booties were issued and were not sufficient to keep your feet warm, but it was not something that greatly affected the mission success. I don't know if there's really much to do to solve that. With the

gloves, if it's going to give you manual dexterity, then they're not going to have a whole lot of thermal protection. The wet-suit mittens have a great deal of thermal protection, but you don't have a lot of manual dexterity.

The dry suits we have available to us at SEAL Team 3 are not dry suits that are meant for diving. They don't have air release valves, so they're really not suited for our diving operations.

We have had a problem on the West Coast with wet suits being poorly constructed. They constrict movement. I guess that's something that's being addressed. Some of the operations that we might be required to do necessitate quite a bit of movement that a wet suit can't allow you to do as far as upper body.

Danner boots sometimes prove to be inadequate for protection against the cold, especially when you're just lying on a reconnaissance. One of the things that we ran into over in Saudi was that the Danner boots, when we were not walking, didn't offer a whole lot of cold protection and to wear socks thick enough to protect your feet, you couldn't get your foot inside the boot.

Adequacy of thermal protection during diving operations; in water temperatures of 40-70°F, the wet suits we have are fairly adequate. I've been diving in 25°F water in Alaska and I used the wet suit I was issued while I was on the East Coast with SEAL Team 4. It consisted of a Phase I and a Phase II. Basically, I was wearing a one-piece wet suit and a farmer john over top of it and was fairly warm. We went out and did a lot of recreational diving and the motivation was there to actually go out and have fun in 25°F water.

Gloves that offer sufficient thermal protection in water of 50°F or less do not offer any manual dexterity.

Combat swimmer missions also require ship boarding, and wet suits do not allow a whole lot of range in motion. They could be cut to allow more. That was something that we tried to address while I was at SEAL Team 4, four years ago, but since then over at SEAL Team 3, I haven't seen much of that.

Operations which require extended transits on cold water would require a dry suit type of protection which can easily be removed and donned to facilitate transition from Combat Rubber Raiding Craft (CRRC) to shore. The dry suits we have now were bought to protect people from water and are basically like splash suits. To get in and out of them in the boat while you're going to the shore is almost impossible. If you have to do it on the beach you will extend your exposure in a hostile environment without much protection.

Length of mission transportation factors. Obviously, the longer the transit to the mission, the more important environmental protection becomes. An example is a CRRC insertion for over-the-beach or over-the-horizon operations. When you're in a Zodiac for

3-4 hours and you're not wearing adequate thermal protection, you're going to be in bad shape before you get to the beach if the water temperature is cold and the air temperature is cold. That situation, obviously, if not adequately protected, can result in hypothermia which can greatly reduce, if not eliminate, mission effectiveness.

As far as impact on the diver, slow coordination in reflexes can reduce endurance and mental capability and reaction time. And, as mentioned, mission success can be threatened by poor environmental protection even when you can function physically; a reduction in mental reflexes can be fatal in a life and death situation.

Examples of common tasks. It's hard to go into that without going into a lot of the tasks that might be classified. The hando' 's seem to cover a lot of the simple tasks when you're diving. Reading a compass is not that hard. There's not a whole lot of stuff to do with your hands except for maybe setting the timer on your watch. As far as patrolling, it depends on how cold you get and what kind of protection you have; it can affect your reaction time as far as the contact with hostile troops.

During Desert Storm, one of the problems we ran into was, like I said earlier, thermal protection while riding around in (FABS), something I became uniquely familiar with. There were times during practice operations where I'd go for 12 hours in 30°F air. Some of the people were having a great deal of trouble because they only had GoreTex on. We ended up having to split up our thermal underwear so that these guys could get by okay through the night.

That's all.

MR. JERMYN: One question. You're saying that you're diving in almost 25°F water in a wet suit, obviously for a short period of time?

HM2 PAPPAMIHIEL: That time I went out on a recreational dive; I was in the water for about 30 or 40 minutes. Now, that is short compared to SDV operations, but compared to somebody who is not in SDVs, it's good amount of time.

DR. HYDE: You mentioned a rather broad range of temperature extremes. Were there any times where you encountered some very different temperatures within one mission or within a short period of time, other than your transitions?

HM2 PAPPAMIHIEL: Well, if you're referencing Desert Storm/Desert Shield, there wasn't a whole lot of extremes. Back in August we were up close to the Kuwait border and we were inland away from the beach. We would see temperatures that would range from about 127-128°F during the daytime. At nighttime, it would drop into the upper '60's, but that was fairly gradual over a period of hours. That was about the greatest range of temperatures we saw over there.

CDR BUTLER: One of the things that would be helpful to Dr. Goforth is to provide a "worst-case" thermal scenario. One of his efforts for the next fiscal year is to provide us with documentation of worst case exposures as we're currently performing them. I think it would be very good if all the operational command representatives could try to think to their worst-case thermal exposure and make that part of the record so that Dr. Goforth can incorporate that into his plan.

HM2 PAPPAMIHIEL: I'll go with heat—125°F in open desert; and for cold, it could be Alaska where the temperature can be actually down to below zero and the water temperature could be, as I mentioned earlier, 25°F or probably less.

CAPT THALMANN: What about water temperature and duration of diving?

HM2 PAPPAMIHIEL: Water temperature on a diving operation would be 25°F for 1½-2 hours in our case. Worse than that would be exposure on an over-the-horizon operation on Zodiacs and that could be 3-4 hours. We're talking air temperatures that could be below freezing and water temperature that could be down in the 20's. That usually ends up being worse than the actual operations, just the transit to the operation.

As far as heat, it could be days out in the open desert at temperatures that could range between 125 and 130°F during the day and in the 60's at night.

CAPT THALMANN: How did you know what the temperatures were?

HM2 PAPPAMIHIEL: While we were out in the field?

CAPT THALMANN: Yes.

HM2. PAPPMIHIEL: With thermometers. Sometimes guys would carry these little thermometers with them out in the field.

CAPT THALMANN: Were those whatever the guys happen to be carrying or do you have standard issue thermometers?

HM2 PAPPAMIHIEL: They weren't standard issues; just sometimes the guys would have thermometers with them. In Saudi, one of the guys had the thermometers you use to measure temperature of a roast in an oven. In Alaska, we had one of those little thermometers in a plastic case that you might clip on your belt loop or zipper.

CDR CURLEY: So, these were temperatures that were just taken as the guy happened to look at it?

HM2 PAPPAMIHIEL: Right.

CDR CURLEY: When he first got in the water during the dive?

HM2 PAPPAMIHIEL: No, it was just out of curiosity. Somebody would ask how cold is it, and he told them. You could look at the accuracy of the thermometer as not being real great, but it was within 5 or 10 degrees, or 5 degrees either way.

CDR CURLEY: What time of the year was this?

HM2 PAPPAMIHIEL: This was in March in Alaska. We have guys up there in the winter time.

CDR CURLEY: You said you did a recreational dive in a wet suit.

HM2 PAPPAMIHIEL: Right.

CDR CURLEY: And, what kind of depth were you at?

HM2 PAPPAMIHIEL: Ten or 15 feet.

CDR CURLEY: What were you doing?

HM2 PAPPAMIHIEL: We were just there as a recreational dive. We decided we were going to go out and collect brass off the ship; not bullets brass, but port windows and that kind of brass.

CDR CURLEY: Did you get cold?

HM2 PAPPAMIHIEL: My face got cold.

CDR CURLEY: You wearing a Phase I/Phase II wet suit?

HM2 PAPPAMIHIEL: That's correct. I was wearing a single hood, though.

CDR CURLEY: What kind of garments did you wear during these 1½-2 hour missions?

HM2 PAPPAMIHIEL: It depended on what I would have to do. Up there we were doing hydro reconnaissance, so the amount of dexterity you had to have was not that great. There were a lot of times we were just hanging around in the water and not doing a lot of swimming. If I was actively on patrol, I'd probably just wear a farmer john wet suit and just swim real hard.

CDR CURLEY: How do you know if you're not performing well? Can you tell at the moment, or is it after the mission?

HM2 PAPPAMIHIEL: Well, you can usually tell during the mission when your concentration starts to go. Probably one of the first things is you find it hard to concentrate.

CDR CURLEY: Does that happen during these cold water missions?

HM2 PAPPAMIHIEL: It can. I've been on missions where I was cold enough that my ability to concentrate on what I was doing, staying on a compass heading, was starting to become difficult.

CDR CURLEY: On the Zodiac transits, you mentioned that you became very cold. Was that total cold or was it just limbs only, hands and feet?

HM2 PAPPAMIHIEL: No, it was totally cold. We had one operation we were to work up for a Mediterranean climate. We were working up in North Carolina during March, I believe, and it wasn't during the dead of the winter; it was during early spring. Guys were cold enough after about a 25-mile transit in the Zodiac where I was very concerned of guys going into hypothermia, including myself. Several guys were involuntarily shivering.

CDR CURLEY: Was there any observable change in performance such as navigation?

HM2 PAPPAMIHIEL: No, sir. We were able to keep up on navigation.

UNKNOWN: The question is when concentration starts to go under exposure to extreme thermal stress, whether there's any particular type of performance or particular type of task (for example, map reading or directional finding) that tends to be more critical or more sensitive or drop out first?

HM2 PAPPAMIHIEL: Personally, from my experience, I find that your thoughts start drifting and it's not that you can't read a compass, it's just that during the process of the dive, I find myself drifting on different things, instead of concentrating on what I should be doing.

UNKNOWN: Could you bring yourself back?

HM2 PAPPAMIHIEL: If I catch myself. It's, I guess, like mentioned earlier, motivation. If you can catch what you're doing and motivate yourself, you can bring yourself back.

CDR POLLAND: When you recognized these things, did you then take some kind of appropriate action? If so, did you come up with any ideas that might be helpful as far as redirecting research?

HM2 PAPPAMIHIEL: For cold operations, if you're in the middle of a dive, there's not a whole lot you can do except try to stay more active, try to swim a little bit harder to warm up some, but again you might throw off your timetable for your dive. There's not a lot you can do until after the dive. It's the "lessons learned" type thing where you can wear more adequate protection the next time you go out on the mission.

For heat, it was a little bit easier because if I started recognizing the fact that I might be going into heat exhaustion, I might start feeling a little dizzy. The first trip out in the Gulf we were living in an air-conditioned barge and we were going outside on a steel deck where it was over 100°F. I'd get headaches quite often out there from the extremes of heat. At that point I would realize that it was time to go inside, cool off and hydrate up a little bit.

When we first got to Saudi we had a lot of work to do setting up tents, and building sandbags. We had quite a few guys go down with heat exhaustion. After the first 3-4 days that wasn't the problem so much as guys getting traveler's diarrhea. But guys were able to pick up real quick on when they should be out in the heat working and when they shouldn't be out in the heat working. So they adapted. I'd say everybody was adapted to the heat within a week. As far as guys knowing when to stop and when to start back up again, it didn't seem to be a real big problem after a short while.

CAPT THALMANN: For cold water operations, three questions. How do you figure out what thermal protection to wear? Number two, how did you decide what to buy? Number three, who trains you to use it?

HM2 PAPPAMIHIEL: Well, the way we decide is you look at how long you're going to be in the water; how long the swim is going to be; or how long you're going to have to return; and find out how cold the water is, if it's possible before you go in. There are going to be some points on actual operations where you might not get an exact water temperature, but you can try to get a good casting of what it is, and that usually determines how much rubber we wear on a swim.

CAPT THALMANN: Does everybody decide for himself, or do you have a guru that tells you what you should wear that mission?

HM2 PAPPAMIHIEL: Well, for the guys who have been around for a little while, it's not that hard. They usually can look back on their experience and say, hey, this is how cold I was diving in this water and I froze my butt off. So they can usually decide what to wear. They usually have a good idea how much thermal protection to wear. The newer guys usually go to the guys who have been around for a little while. There are suggestions out there in the dive brief that you wear full wet suits, but there are times during some dives where a full wet suit might not be adequate protection and you might need something underneath.

CAPT THALMANN: Does it ever get written down?

HM2 PAPPAMIHIEL: During the dive brief, but it's not something that's passed on after the dive except for personal knowledge.

CAPT THALMANN: How do you decide what kind of equipment to buy?

HM2 PAPPAMIHIEL: Experience and how much money you can afford to spend on it. A lot of the SEAL teams on the West Coast aren't issued Phase I and Phase II. The SEAL teams on the East Coast have a range of water temperatures a lot greater than in Coronado; so the training dives you'll be doing in Little Creek can be a lot colder than it will be in Coronado. I think that probably is a big factor on what kind of equipment is issued.

CAPT THALMANN: What is issued? How much discretion do you have to go out and buy something?

HM2 PAPPAMIHIEL: As much as you want. As long as it doesn't adversely affect the operation.

CAPT THALMANN: How do you do that? Do you go to your local scuba shop and see what's in the window, or do you look at a catalog or does somebody come up with some ideas from the latest literature?

HM2 PAPPAMIHIEL: A little bit of all of that. You look and see what's available in the local dive shop and if they don't have what you feel like you need, sometimes you can look at their catalogs and you might see something.

CAPT THALMANN: How do you decide it works, then?

HM2 PAPPAMIHIEL: Well, if it's something you're going to buy on your own, then you find out from talking to the people who run the dive shop. If it's a catalog, you probably buy it and just take a chance that it's going to work for you.

CAPT THALMANN: How much stuff have you trashed because it didn't work?

HM2 PAPPAMIHIEL: Quite a bit.

DR. DOUBT: One last question and then we need to move on.

DR. GOFORTH: We've been along on about 15 SDV missions and five or six combat swimmer missions in cold water and I can provide you the list of this plethora of items that these guys wear. He's made every comment correct. They vary from individual to individual and they may not get trained, or know the value of a thunder glove versus a wind-surfer glove. It goes on and on. So, I can provide you the list of these things. We're trying to have a checklist so they can just check what they do. We have to add something

new to the list because it's the latest thing out.

CDR CURLEY: That would be useful for these proceedings if you get that list to Dr. Doubt. It's a list of every known piece of thermal protection gear that's ever been tried and some comment as to whether they decided they were okay, not okay, or great.

DR. GOFORTH: The evaluation part will be variable, but I can certainly get you the list of it.

DR. DOUBT: Some of the comments are well taken, and some of them can be amplified a little in the round table discussion. The next presentation is from SEAL Team 4.

SEAL TEAM 4

LT KASEL: I have a nickel handout here of an overview everything SEAL Team 4 does. I've been in the team for 12 years. I was a corpsman beforehand, so I've got a variety of experiences in the community. I've been at UDTs, SDVs, SEAL Team 1 on the West Coast; I'm now at SEAL Team 4 here on the East Coast. I've also been involved in a couple of simple studies to decide which dry suit to buy.

SEAL Team 4 RAO is centralled in South America and covers the Caribbean. People generally would relate that to nothing but hot weather. I would like to tell you that Plutode Amos is about 60 nautical miles from the Antarctic and it gives you an idea it is kind of cold down there. I should know.

Just going down the list really quick. Air temperature may vary from 120°F to -40°F chilly. That's Ecuador 120°F; the country of Chile has the greatest range for us probably for any country. They have these plus or minus 10°F at least.

A big point is humidity. Anywhere from Panama down to Argentina the humidity plays a big factor on what you wear and how your operations going to go.

Water temperature from 90 to 26°F and now that's not just here in the Chesapeake Bay, it's everywhere we operate—from the Caribbean down to, again, Pluton Amos. When you swim with the penguins, you know you're cold.

Seal Team 4 is getting into riverine warfare and jungle warfare environments. Every operation that we do generally has water and land mixture. So, we're in the water, we're wet, we're dry, we're wet, we're dry and that may go back and forth numerous times.

A normal dive we just pretty much dive Draeger to 20 feet. Generally our dives are 2 hours or less. It's not like our old SDV days where you could spend 13 hours on one dive. If you're sitting up here in the middle of February it was about a toasty 30°F; we left here and jumped into Puerto Rico. So trying to decide what to wear is difficult. What we

generally do is wear what you're ultimately going to wear on the operation.

Range of times and targets—anywhere between 10 minutes and a week, depending upon what you're doing. If you're just sitting out there for surveillance, you might be there for a while and temperature might be hot or cold. Sitting out there you might have a temperature of 120°F during the day and when it gets dark, it goes down to 40°F. So, the variance is quite large and it's hard to predict.

Thermal protection garments. You already spoke about the dry suits, the wet suits. It varies depending on who's making it and who we're buying from; who we're friends with at that time. We wear the polypropolene long underwear and GoreTex light and heavy weight. We also have the medium weight. It depends on what command you're at. SEAL Team 4 focuses on jungle warfare and they forget about the Bolivian Mountain, the Andes, Chile, Argentina. So we're starting to finally make a transition to get some cold weather gear.

Criteria used for selection. Until recently, our supply department just bought whatever they felt we needed. And we're sitting there going, "No, I need this." We're out in the field getting wet, tired, cold, hungry. The thing the XO and CO brought up is we're starting out meetings with the supply department saying, "We want this gear." The XOs and COs don't get out in the field as much and haven't tried the newest gear that we get issued. I just spoke to the XO about this recently and said that the guys that are out doing it need to come up and say, "This piece of gear stinks."

I can relate back to an operation that we had in December a couple of years ago. It was probably 0°F air temperature and the water temperature was about 28°F. So the water was actually warmer than the air. I still have no feeling on the top of my right hand because of the gloves that the supply department said, "These are the best that we have and they worked for me." Well, they didn't work for me. Well, now we have a supply department that listens, "Hey, this does not work. It's a nice piece of equipment when you're going from your car to your house and walking around." That is something that needs to really be brought up because you have to have the operators involved with all the discussions about equipment.

Protection for feet, hands, and head. Currently, the GoreTex gloves which I spoke about and standard leather gloves. Just a black leather glove with a wool liner. Personally, that's probably my favorite, even over the GoreTex gloves. Danner boots and jungle boots have been addressed. Jungle boots, they're still doing their job for immersion foot and trench foot that we still seem to be facing quite often. Nothing probably like the Vietnam days. It's still out there and never going away. That's something that sometimes you just can't avoid.

Effects of working conditions on mission performance. Adequacy of thermal protection. I saw this dry suit I liked for diving. I was lucky I was the guinea pig on a dry

suit/wet suit experiment. I was diving the Phase I/Phase II right here in Little Creek. It was 26°F, we took a water temperature; we broke the ice; put the SDV in and we went out on a full mission profile and came back approximately 6 hours later. I was talking about the function tasks. I remember trying to place my limpets and to do everything was two-handed because your hand is frozen. I could walk to the shower. I saw many a dry suit personnel carried and taken by ambulance to Emergency Rooms (ERs) to be taken care of. So, I am very partial to wet suits. I do not like dry suits.

Going back to another mission, we were using the dry suits for protection. They protected us from the air temperature; the splash of the water. They had a very good use there. The problem was nobody could use their hands.

CAPT THALMANN: Do you not like the dry suits because they leak or you don't like them even if they don't leak?

LT KASEL: I've never seen one not leak. As soon as you get a leak with the dry suit, within 10 minutes if it's 26°F water, you're pretty much non-functional. You can be cold with Phase I/Phase II wet suits. Phase II was like a farmer john with gloves and you layered it. We usually put it on with a hot lava. So, we had warm water already in there keeping the body temperature high. We'd go out and dive. You could dive, you weren't great, but you were functional and that's why I don't like the dry suit personally.

But, when we do rubber ducks—when you jump out of a plane into the water, get into a CCRC, it's proven functional and has been very important for us.

CDR POLLAND: The comments you made about having people injured or endangered while wearing the dry suit, to what extent did these people recover without any incident? And, if so, did you amend your policies as far as from the command level, or from the SEAL Team level, SDV Team level, to changing out of the dry suit pretty much? Did that change your policy?

LT KASEL: Yes, sir. Nobody died from it. Everybody that was taken to the ER was mostly just hypothermic; everybody recovered full use. And we did amend it. We stopped using the dry suit. We kept shopping for one at SEAL Team 4. Just recently we had someone come over and present a new dry suit to us.

When I left SDVT-2 in 1984 we had not come up with a good replacement for the Phase I/Phase II. I'm not talking for the SDV Teams now. They're probably going to easily find a replacement for the ones that we had at the time. I don't know. But, at the time, the Phase I/Phase II was working the best for us.

CDR POLLAND: One final question. If you're on an operation and you don't have a leak and everything goes along and you're doing something and all of a sudden you spring a leak, you're in trouble; whereas, if you're wearing a Phase I/Phase II dry suit, the

probability of you having a major catastrophe relative to the dry suit is a lot less?

LT KASEL: That's right, sir. If the dry suit leaked through the wrist or the neck, the guy would just move and all of a sudden he would feel all of the water just gush in and his body temperature automatically drop. I don't know how fast your body temperature drops, but you can see a 10-minute transition.

With the Phase I/Phase II, you know that water's got to work its way up and down and your body—you're kind of moving around and you're still producing heat and trying to keep that water warm. I think that's what saved the Phase I/Phase II people.

DR. DOUBT: I don't think you had quite finished your presentation before we got into questions. So, if the audience could hold further questions until he finishes his presentation.

LT KASEL: We used the wet suit in all the dives that we did down south in Chile and Argentina. We did use the dry suit for beach reconnaissance. That was nice because we'd fill it up with air and you could float around really easy. Since we weren't doing anything tactical, it was great.

Length of mission, transportation factors. Like I said, we can be sitting up here in Virginia Beach, Virginia, for hours and it might be freezing cold sitting in a C-130 waiting for everything to be clear down in Puerto Rico and Panama and that has happened numerous times. Current diving missions tend to be short. If there's anything we need to do, it's probably very quickly, all of a sudden.

I could go into different types of tasks. We've done 8,000-yard compass swims, less than SDV; doing turtle backs and dives here in Virginia Beach and it's probably our worst operating area because of the change in temperature here. Sometimes the water is actually warmer than the air. I'm thinking back to one FMP we did here. The water temperature was about 30°F; the air temperature was about 20°F, and I'm not sure what the wind chill factor was. One guy went completely into convulsions. All of a sudden he was just walking around after the mission and went into complete convulsions and he came to a full recovery, but about 10 people on that dive still suffer from some type of numbness in the extremities and in general, it's related to the hands.

CDR BUTLER: All the teams have an incredible range of environmental conditions that they might have to work under. If you would just go back over for us the coldest water, longest dive that you're doing fairly routinely. You know, your worst-case routine exposures.

LT KASEL: Well, as we speak right now, we have a platoon doing combat swimming with the Chilean Navy. I'm sure it's about 26, 28°F, 1-2 hour mission profile dives. We have a platoon in the Chesapeake Bay doing combat swimming. Again, 2-3 hour

profiles and I'm not sure what the coldest water was here, but it's cold.

The greatest extreme probably is the platoon that's about to leave from here to go down in Panama. You've got the temperature change here in December, extremely cold, to extremely hot. Platoons working in Ecuador in the desert and the Chilean desert find 120-125°F temperatures. They can fly out of Panama with that high humidity which I really think affects people going from a high humidity, high temperature to a high temperature and no humidity. I know that really wipes out people.

DR. THOMAS: What kind of things do you do, or what kind of things can you do to help you prepare for this kind of tough transition? If you're sitting out here in a cold cargo plane waiting to go to Panama, what can you do?

LT KASEL: The biggest problem is that you never know if those things are going to occur. You try to prevent them. You're sitting there, you put your chute on, strap yourself in. What we use are Navy issue wool blankets. It seems to be the best thing we can do for ourselves because you don't want to jump with any extra equipment on your body, if you can't put it on your boats. So, you bring extra blankets. It is the best thing that we've come across so far. I also can't say enough about gloves, making a guy sit there and wear mittens while they're sitting on a plane waiting for permission to take off.

CDR CURLEY: How do you evaluate your training missions—how successful they were? What kind of criteria do you use?

LT KASEL: Did we get the target? Could we have destroyed the target? How many people actually hit the target? There's really no report in our community of what has happened. Any cold weather injuries are lessons learned from post operations. Unfortunately, that post operation generally just ends with the mission. Training exercises stay with you. I remember what happened to me 10 years ago. That's how it gets done.

CDR CURLEY: So, basically you're looking at the end point?

LT KASEL: Yes, sir.

CDR CURLEY: Was the objective reached and you don't focus on what happened?

LT KASEL: Generally not. How do you know what to wear? Ask the chief, he's been around for three deployments down there; he knows what it's like. Each person has a different spectrum they can understand. I like the comment, "How much gear did you buy and how much do you have just sitting around the house." Quite a bit. It's too hard to plan right now.

CAPT THALMANN: If I went to your mission reports, would I be able to tell you what equipment you wore and how well it worked?

LT KASEL: You could find out what I wore, but you couldn't tell how well it worked. Right now, every mission has a brief. Every time we go out to do something, there's a brief. As an OIC, I just put out the minimum amount of gear that you should be wearing. I can relate back to my experience and say, "I know how cold I get." "Yes, this is when you need a full wet suit, but this is optional", or I'll say "What suit is mandatory gear?"

CAPT THALMANN: After the mission is over, does your report reflect what was actually used and whether or not it worked?

LT KASEL: No.

CAPT THALMANN: So, all you know is what was advised to be used? So even after the mission is over, there's no documentation that we tried out this new wet suit and just didn't like it.

LT KASEL: The only ones I can say doing that were when we're actually testing wet suits and dry suits.

LT KAUFMAN: Do the mission reports document how well equipment functioned?

LT KASEL: If it was just one, you might get somebody writing up a point paper. I try to do a lot of those things and send them in and say, "I think this piece of equipment stinks." It might just go to the supply department saying, "Hey, how about if we look at this piece of equipment." Right now our supply department is a little more open minded and it takes a look at those things and says, "I'll think about it."

HM2 PAPPAMIHIEL: The only time that we might see that kind of report coming back on equipment is if there's a casualty on the operation. That's because it's brought out in the investigation.

DR. DOUBT: The next presentation is from SEAL Team 5.

SEAL TEAM 5

LT KAUFMAN: A majority of what the other operators have said has been accurate in my view. However, I'm going to add a different perspective in that I was a member of the ARG deployed for Desert Shield and Desert Storm in the Persian Gulf, from September through late March.

Team 5 is now area specializing and we're going to be assigned the Northeast Asia AO, so we're going to be very involved with cold weather and that's why I'm here. Currently for training areas, we use Kodiak, Alaska, Washington state, and the California deserts. Those are our predominate areas. For the ARG, the biggest challenge is

transitions. You'll start on the sterngate of an amphibian in a Zodiac. I think one of the biggest limiting factors in this type of cold weather operation is limitations on what equipment you're going to be able to take. Frequently you can't leave things like limpets behind, so cold weather gear is left. Normally it wouldn't be uncommon for you to start out in a splash suit; change over to some sort of diving gear, wet suit; go ahead and complete the operation; come back and for your extraction, change back into your dry suit or splash suit.

And I use the term splash suit because SEAL Team 5 doesn't have dry suits. Their version of a dry suit is what's called an exposure suit. It is basically a rubber jacket that you wear with seals around your neck and wrists to keep the water out. If it doesn't leak it's a good piece of gear. At $1,000 each, they will leak in a matter of one to two operations, so personally I feel they're a waste of money. They're just expended at an unbelievable rate. My platoon of 18 men were in Alaska for a period of a month. By the end of that training period, at least 9 suits didn't work and I'd venture a guess more like 15 didn't work.

I think one of the major reasons why they don't work is not because they've got punctured, but the seals around the neck and arms basically just break. Once those seals are broken, the dry suit is basically rendered useless. I think that's a real safety concern too, because in the transits through Kodiak waters, they are unmarked waters with a lot of rocks. If a Zodiac ever flips over and a guy has a broken seal, he's going to have a real hard time because that 30°F water at about 30°F air temperature is not going to allow him to survive very long. In fact, I was in a transit and my dry suit didn't work. My neck seal was completely gone. If we had gone over, I don't think I would have survived.

Like I said, the ability of a Zodiac to carry the equipment needed, especially in an operation like that, is severely limited. We had to have one guy strictly as a boat driver and no more than three personnel to actually operate in a mission per Zodiac. So, the more Zodiacs you have, the more complicated the mission becomes, and the number is inversely proportional to your chance of success.

Our garments, with the exception of not having a dry suit, are the same as for the other SEAL teams. I'd like to really reemphasize the fact that $1,000 an issue for these splash suits is unreasonable; there's got to be a better alternative. In addition, we generally use GoreTex and polypropolene, but I think for every SEAL that's out there, there's a different uniform in every operation.

I definitely agree with the statement that a lot of guys go out and buy whatever they feel will do the job, and I think predominantly it's trial and error. I don't think we have some sort of special knowledge that most consumers don't. If somebody finds a piece of gear that works, word gets around and eventually it's incorporated into the system. However, it does take a while.

A point I'd like to stress that has not been mentioned is food. No one's ever talked

about food and cold water operations. I think that it's a real important point to have some sort of high carbohydrate diet to keep your body supplied with the energy it needs to keep warm. In fact, we tried to get Power Bars before we went up to Alaska and they laughed at us because that's something they have to open purchase. There's nothing ever said about food and a high carbohydrate diet; I really think it would help the cold weather operations.

Another thing that might be considered is coming up with some sort of antidiuretic, especially for cold water operations because you lose a lot of water through liquid loss. I know for every diver out there in cold water, they've used it to warm their wet suit and I think ultimately that decreases your overall core temperature.

A couple of points that have been brought up are the conditions for grading success. Either you complete or you don't and I think that's the bottom line for the SEAL's great success rate. If you do the job, the mission's considered a success; if you don't, it's not considered a success. And I think it's predominantly left with the individual to grade his or her own success on the mission; whether or not he got lost along the way; whether or not he was comfortable; those types of facts. And as far as Team 5 is concerned, there really isn't any post-operation reporting that is included in these types of missions, especially within the area of thermal protection.

There is some degree of reporting as far as OREs and that sort of thing, but by and large the training missions aren't followed up by any sort of paperwork. There really isn't much literature on the subject of thermal protection as far as garments are concerned. During training missions, you know you're doing the job; it could just be done a little bit better. I feel with some additions to our equipment and maybe a little facilitation getting the equipment, the job could be better done.

As far as supplies are concerned, I've got to say that we've got a good working relationship with our supply department. They realize that they have no idea what we do and they depend on us to provide input for them.

CAPT THALMANN: How much trouble would it be to, after a mission, specifically look at the equipment that was used and whether it worked or not?

LT KAUFMAN: I don't think it would be a pain in the neck to do. I wouldn't mind doing something like that, but I think it would have to be generated as a standard format. If it was left up to the individual platoon commander, standardization would go out the window and there wouldn't be any way to really compile the data that are received.

CAPT THALMANN: So, right now you tend to focus mainly on whether the mission was completed or not?

LT KAUFMAN: Yes, sir. Unless there is a failure in the equipment to do the mission—like the boat breaks, or a limpet doesn't work.

DR. THOMAS: What are some personnel kind of breakdowns that could cause a mission not to be completed? What type of problems occur in people's performance that would jeopardize a mission?

LT KAUFMAN: I would say loss of manual dexterity to get the correct setting on his limpet because he was unable to use his hands properly in those conditions. That would be one example that comes to mind. I don't really have many specific examples.

CDR BUTLER: Have you ever been on an operation where an operator has said, "I'm too cold. I want to go back. I don't feel that I can function adequately and I think that I'm getting dangerously hypothermic"; then turned around and went back to the base before the mission was done?

LT KAUFMAN: No, sir.

CDR BUTLER: Has anybody here ever seen that happen?

DR. GOFORTH: Yes, I have on an SDV operation. The guy said, "I can't - can't continue" and they took him out. And also in another SDV operation in Bangor, when they were trying to do the race track circle, the pilot decided that this was going to take too long and he too aborted.

CDR BUTLER: Because he was too cold?

DR. GOFORTH: Too cold.

CDR BUTLER: How long had he been in the water?

LCDR WOOD: In regards to Bangor and the guys speaking up regarding whether or not to continue the mission, that is not really how it occurs all the time. You would be hammered for doing that, so to speak, because you couldn't leave the mission.

In regard to our Bangor training, we provide specific guidance in a letter of instruction to the OIC that they will mention or stop the operation if there is a thermal problem with the diver. So that's why you will see in SDV Team 1 in Bangor, the guys will surface the boat and mention if they have thermal problems. In most cases—whether it's right or wrong—completing the mission is more inbred into the operator than stopping the operation and saying, "I'm cold; sorry I can't keep going."

DR. DOUBT: Are there examples where your dive buddy or somebody else may observe something that somebody else is doing and say, "This has gone far enough; that this person is incapacitated."

LT KAUFMAN: I can answer that one and say definitely yes. In some of my

experiences in Kodiak, we had to stop and let a guy drink some boiled water in order to get him warmed up again to keep going. It wasn't a situation where we turned back, it was a situation to solve the problem.

DR. DOUBT: Who made that decision?

LT KAUFMAN: It was the platoon commander, of course, who ultimately made the decision, but he was advised by the corpsman.

DR. DOUBT: What were the signs?

LT KAUFMAN: I would say general hypothermia. He was incapable of going on at that point.

UNKNOWN: By definition we know that hypothermia is something that usually comes to the recognition of those around you, not from the one that is hypothermic. He may be wandering off and not even aware of that. That's part of the problem. It's been already pointed out by a number of SEALS that the mission is essential, so that's inbred.

Many thermal problems occur in the hands and feet. Once you've compromised someone's hands and feet, as most military analysts know, you have stopped the mission. In fact, you have killed it unless you can take care of him. What are you going to do with him when the rest of you are supposed to go on?

LT KAUFMAN: In reality, I would say there is a good possibility that we would leave someone to take care of him and complete the mission and get back to him.

LT KASEL: Sometimes you have no alternative but to take the guy along. I thought of six situations, four were cold and two were heat. You can't afford to stop; you're not going to get anybody to get you out of there.

On the Chesapeake Bay, when it happened to me, there was nobody to come out and get us. We were out there on our own and we still had 6 hours to go. You can't build fire in a CRRC. We were swapping gear trying to keep everybody at the same level of being cold and miserable. The problem with that is that you might not be able to do anything about it. You are fortunate if you can boil water; sometimes you don't have that luxury. If the situation dictates, you have to make a call as a platoon commander. Sometimes, you know, it's an adverse call, and sometimes it's like overwhelming.

CDR BUTLER: Just for the record, if you would recap for us your worst-case thermal exposures—duration, temperatures, dry/wet.

LT KAUFMAN: My worse thermal exposure I think would be in Alaska in Zodiac transit with a leaky dry suit. The transit time was about 2½ hours; weather approximately

30°F; water temperature about the same; and sea state three. I would say my worst diving case would probably be 40°F for half an hour, sir, in a wet suit.

DR. HYDE: Have you ever experienced a situation where thermal status of the whole team was compromised to a point where you said, "Okay, the mission is compromised and the chance of success is practically non-existent?"

LT KAUFMAN: I've never had a situation like that once a mission actually started. We've scrubbed missions before they started in Alaska, specifically because there was no way that we could have gotten there in the sea state, but it was more a question of sea state and not thermal exposure.

DR. THOMAS: The average duration of most of your missions?

LT KAUFMAN: They range from anywhere from half an hour to a week. If there's anything I could sum up, it would be the fact that most of the SEAL missions will at some point use a Zodiac, at least especially from ARG. The mission equipment is more important than what you're going to bring to stay warm. And two things that I think could really be improved are the food issue and the possibility of chemical supplements to make your body warm—resistant to the effects of cold.

DR. DOUBT: From SEAL Team 8 is Master Chief Jarvis.

SEAL TEAM 8

OSCM JARVIS: A lot of what I'm going to be saying is pretty much an iteration of what's gone on before. A few things are a little different because SEAL Team 8 has an area of operations that's kind of limited in its environment. We deploy to the Mediterranean and that area would take us to Africa and the Middle East. We had people in Desert Storm and Desert Shield and Provide Comfort. A lot of the things I'm going to mention are things that were learned there. We've also had mobile training teams deployed to Morakati in West Africa and the Mediterranean ARG that also went down as far as Liberia.

The air temperatures and the water temperatures we have are probably less severe than what the guys have in terms of cold stress, but we have definite heat stress. In the Red Sea, the temperature of the water can get well above 90°F. Salinity is a factor there also. The air temperature in the Middle East, as you're all aware, can get up to 120°F and extreme fluctuations occur. Subsequent to Desert Storm, the Provide Comfort evolution was pretty extreme for some of the guys. They would be working in extreme heat during the day, be in remote field sites and have to put up with temperatures in the low 50's (°F) at night.

We deploy primarily as ARGs and such like that. We had ALJs with us in the editerranean and in Liberia. So that's where SEAL Team 8 is. We work in that

environment. Air temperatures really below freezing, and well above 100°F. Low humidity is really a factor in that environment except down below the Equator. Mobedishu is still pretty much a desert area.

We're more with the ship or submarine than just about anything else. We don't do much that's air delivered so we're going to have to do some kind of water transition somewhere along the way—either to get to or to get from our objective.

Our usual diving depths are pretty much limited by the Draeger, which also limits our exposure so we're not in the bad situation that the SDV people find themselves in. In that environment, the Draeger will fail long before a guy with just a normal wet suit material is going to suffer extreme thermal stress.

The ranges of the times of targets, though, become an issue for us. We have to do longer transits and remain longer on the target because the area we're in usually involves extreme open areas—no cover, no concealment. We're probably transiting longer ranges and walking longer distances if we're going in by foot. So, our times of targets can be in excess of 2 weeks. That also brings up a point that was an issue for us; we looked at it for Desert Shield/Desert Storm. It was the idea of thermal detection in an open area. In that environment sometimes a thermal signature is a limiting factor for us, whether it's wide open water or the desert. A Zodiac gives off a significant signature and bodies give off a significant signature in darkness. So, a lot of the concealment that we rely on would be compromised by that.

The type of thermal protection we have is pretty much standard. The guys will wear GoreTex, polypropolene, some woolen underwear and that kind of thing in the case of cold. In the case of heat, we were fortunate enough to be able to get something that we found to be better for the heat than the standard issued desert cammies. Those (desert cammies) were made out of a material that we thought was unsuited to the heat. You could argue whether that was a good camouflage pattern for that environment, but the fabric was not suitable at all. It was very heavy fabric, the old BTU type—it was cotton and nylon mixed. We bought a straight khaki color, very lightweight jungle warfare type utility. They were of khaki color which we thought blended better and they were loose fitting and extremely light. We found that they worked a lot better in the desert environment.

What criteria we use to select garments. Again, it's kind of a hodge-podge. You try to go with the most experienced opinion that we have within the team when we go to procure equipment. It's still a pretty subjective process, as I am sure it probably is in all the other teams.

The protection that we use for our hands and our feet. Since we're not threatened by the cold to the extent that cold weather teams and the SDVs are, it's not that big of an issue. We find that wool inserts and the leather gloves are extremely durable, so we tend to favor that. GorTex gloves are nice and the regular diver's mittens are sufficient for what we do.

One of the limitations we have for garments is an extreme limitation on gear storage. When we make a deployment, very often it's in conjunction with an amphibious ready group and consequently we have very limited deck storage for any of our gear. So our guys are kind of limited to the amount of gear they can take with them. They can't bring a broad array of gloves, GoreTex, different types of long underwear, splash suits.

The effect of the working conditions on a mission performance. Launching from a ship is pretty stressful in itself and limits the gear. We're faced with long transits in Zodiacs and then having to go ashore or having to enter the water. So, it's like having to do a quick change in the middle of a floating rubber boat. That affects us quite a bit, and limits how much the boat can carry. We don't have that kind of stress on our divers.

Examples of common tasks we perform. An example might be where you have to launch from a sub where it's nice and air conditioned; do a long transit to a desert environment and then have to stay on land for a long time. Having transited over the water, invariably your gear is going to get wet in a Zodiac. It hasn't happened yet that they could keep anything other than small electronic components well water-proofed. In the desert it has been our experience that you really can't avoid getting some kind of sand and grit on you, so that takes its toll in chafing or whatnot in equipment, because being wet, it attracts the sand and then the sand doesn't shed very easily.

Another example might be a launch from an amphibious ship which is extremely hot within the confines of the hull; do a long transit through fairly cold water—like it gets into the 50s (°F) in the Gilbraltar area—and then have to do a combat swim. So they'll launch from the heat; then, shocked by getting into the rubber boats and going to do a long drive with essentially no activity. It's difficult in the Zodiac transits to maintain your temperature because you're basically sitting there for hours on end, and then have to switch into some kind of equipment that's sufficient to do the dive.

The problem of thermal stress is more often the transit than the dive because, again, the Draeger limits how much time you can spend underwater. While you're underwater you're working and you're generating some heat. You have a wet suit you can wear that works well in the water. A wet suit is not very good in the open air—wind chill takes its toll there.

We tried different kinds of dry suits. The one we have that works well is a splash suit, over top of say a combat swimmer's gear for the transit. It has certain drawbacks. It works well on the surface, but has no provision for urinating. That's always been a problem on long transits. And being made of GoreTex, it does have the problem of making some kind of synthetic fabric noise on targets. All the GoreTex does that.

DR. HYDE: You talked about your water transitions and you mentioned very briefly about going from a hot ship to cooler water situations. Taking that a bit further, if you complete a mission in the hot air environment do you see it as a problem, then, having

to come back and transit either on the surface or submerged in that cool water environment? Do you do that very much?

OSCM JARVIS: Well, we usually don't go right from the hot to the cold. If we're extracting from a desert environment, we usually go over the water; we can't stay submerged that long. If we are going to be submerged, our gear is going to limit how much time we spend submerged, so it's not really a problem area.

We see problem areas in the case of heat stress. Nuclear, Biological & Chemical Warfare (NBC) equipment would incapacitate you in a short period of time in a desert environment. Even without NBC equipment, we've done survival training in environments like Fort Bliss, Texas, and the Tucson area. There it's not just a question of gear, but there is I guess a biological limitation. You just can't put out very long in that kind of an environment. We have had guys routinely go down and need i.v. supplements because they were just on the verge of some kind of severe heat stress. I don't know what there is in the way of equipment that would alleviate heat stress in 100+°F temperatures—at least anything that we could take.

DR. DOUBT: You had mentioned the problem with thermal signatures coming from the bodies in warm environments.

OSCM JARVIS: I'm not so much thinking of warm environments. I think in a place like Puerto Rico it's probably not a problem, but over the water and in the desert at night where you have a colder background, then you have a higher contrast.

DR. DOUBT: What kinds of things do your people do to hide the signature? You mentioned they tried to hide the signatures by putting equipment over them.

OSCM JARVIS: Yes, ponchos are often used, especially on a boat. You have some kinds of little sound covers that come with the motors and we found that those reduced the heat signature somewhat. We just put ponchos on and keep a lower profile in the water. On land, terrain masking is about as much as you can really hope for. Through our experience there wasn't much you could do except to douse yourself with water to try to reduce your heat signature. That's just not an option in the desert environment. There's not really a whole lot that could help us in that regard unless it was like wearing some type of a space suit, and that would probably produce overheating.

The NBC equipment was the biggest problem because that was considered an immediate threat force. Somebody having thermal imaging to detect us was considered at this point to be not as great a threat. We could see it coming because anybody can buy one of those.

CDR BUTLER: For the record, your worst-case cold water immersion and exposures.

OSCM JARVIS: Probably it's no worse where we deploy than it gets here. Since we do have long transits, we've had people with hypothermia prior to getting to the target with things like frostbite just during the boat transit.

CDR BUTLER: Times and temperatures:

OSCM JARVIS: Fifty-mile transits and just 40 or 50°F air temperature, but with strong wind so that the seas break. That debilitated a few guys.

CDR BUTLER: And water temperature and time under water?

OSCM JARVIS: Water temperature is usually about freezing; our times in the water, usually no more than about 4 hours - just immersed in the water. That doesn't include the fact that we might be transiting for hours before and after. So we would be wet a good bit of that time.

MR. DUDINSKY: That transit of 50 miles takes you what—about 3 hours or so?

OSCM JARVIS: It depends on what we're carrying. Usually a lot more than that because you don't want to drive too fast in areas where you don't have any good navigation aides. So, it could be like 6 hours.

DR. DOUBT: Next, we'll hear from SDV Team 1.

SDV TEAM 1

LCDR WOOD: I'm currently the Operations Officer at SDV Team 1.

I have some handouts. I'm going to go through the information with you and in any particular area that I might consider classified, I'll just have you refer to the handout for times, depths, and temperatures.

A little bit of background on myself. I had experience in Vietnam with SEAL Team 1; ARG experience with the UDT 12; I have dry deck shelter (DDS) and SDV experience with the SDV Team 1.

Regarding environmental conditions, I'll discuss ranges of air and water temperatures that affect SDV operations. Our operational area is the Pacific fleet, which involves a wide spectrum of air and water temperatures. Our mission environment requires us to operate in air temperatures from below freezing to 130°F, as experienced in the Gulf.

Training environment. Our main cold water training area is in Puget Sound at Bangor. Air temperatures range from 40 to 115°F. Water temperatures range from 42 to 85°F.

We have some missions that are in the 29°F water area. Based on our current thermal protection garments, and SDV mission times of 6-12 hours, we cannot operate in 29°F water. Realistically, we can conduct 6- to 12-hour missions in 42°F water.

Frequency of air/water and land/water transitions. SDV Team 1 has no air/water operational transitions. A majority of our operation plans call for a land/water transition—or a water/ land transition. Most of our missions conducted in support of fleet exercises, however, are typically water oriented only. For training purposes, approximately 50% of our training involves land/water transition.

Standard dive depths. I have a listing of mission-specific depths for transits and for target areas. Refer to that for the depths.

Time ranges for insertion and distractions. When you're looking at overall mission time duration, you have to consider not only insertion and extraction times, but you also have to consider the host platform. It may be a surface vessel or the DDS and submarine. When you operate from the DDS you have to incorporate waiting periods of 30 minutes to 3 hours. These waiting periods impact on total thermal exposure time.

The insertion and extraction times are 1 to 4 hours; DDS waits range from 30 minutes to 3 hours. The DDS wait depends on the submarine CO and what's happening on the surface.

Time ranges for actions of the objective. I have them listed mission specifically in the handout. I'm not going to mention them here.

Thermal protection garments. The circle of using different dry suits is complete. We started with the Viking dry suit; transitioned to the Passive Diver Thermal Protection System (PDTPS), changed to DUIs TLS dry suit, and returned to the Viking. I think during the PDTPS and the DUI period is when SDV operators lost confidence in the reliability of the dry suit. Leaks were very common. The Viking/Nokia suits have been extremely reliable and we're pleased with them. Now I'm going to qualify that statement by saying that the majority of the SDV operations are passive and not active. So what's good for us in the Viking/Nokia in a passive mode may not be good for a SEAL on a combat swim because the Viking/Nokia suits are stiff and restrict movement.

The handout has a list of garments. We're using the Viking/Nokia dry suit. For undergarments, we use anywhere from C-200 to C-600 Thinsulate. I don't have the clo values listed.

On the West Coast we use the Phase I/Phase II wet suit. I think it's designed a little differently from the East Coast Phase I/Phase II in that our Phase I portion of it is the 3/16 inch and our Phase II jacket and the farmer john are only 1/8 inch. I think theirs is reversed. Check with the East Coast on that. If you add the thickness of rubber on the torso for the

Phase I/Phase II, you have 9/16 inch of rubber if you wear the whole thing.

We also have the standard issue SEAL wet suit which is a 3/16 inch farmer john with a hooded jacket and shorty tops/bottom. Other things we wear are polypropyline and lycra suits. They're not really for thermal protection, but more for preventing grit and sand from getting all over our bodies while we're transiting from the dry or wet suit to our land operational gear.

Garment selection criteria. A lot of things are based on experience and individual preference. If an individual is choosing something that will compromise a mission, then the mission will dictate what he's going to wear. A rule of thumb for us on the West Coast anyway is if it's below 54°F water temperature, we wear the dry suit. If it's above 54°F, we will wear some form of the Phase I/Phase II wet suit.

I'm not going to talk about land/water equipment because that's been addressed by the other SEAL Teams. I will address criteria for selecting dry and wet suits. Temperatures are listed in the handout. Those temperatures are not scientifically derived. It's based totally on our experience at SDVT-1. I've had several people review the list and agree on its validity. The basic breakdown is: 42–48°F: a dry suit with a C-600 Thinsulate; 48–52°F: dry suit with either a C-600 or C-400; 52–54°F: dry suit with C-400 or C-200; above 54°F a Phase I/Phase II wet suit. These ranges encompass factors like body fat. An individual like myself, with the perfect SDV body (20% body fat) means I could wear a C-200 where my skinny pilot would have to wear a C-400 to just survive the mission.

The East Coast missions and their use of Phase I/Phase II wet suits do not relate to the West Coast. Our SDV missions last 8 hours plus and generally around 10–12 hours of submerged operations. Our Phase I/Phase II temperature limit is 54°F.

We've conducted full mission profiles in 54°F water from a DDS. That temperature pushes the SDV operators to their limits as far as completing the mission with reasonable levels of alertness and motor skills. For us, 54°F is the dividing line between wet suits and dry suits for 8- to 12-hour missions. In 60–70°F water we use just the Phase I with the Phase II top; in 70–80°F, only the Phase I; and 80–90°F, required only a shorty wet suit.

The head is probably where we have the most heat loss, and we have the least thermal protection. It is just a latex hood and a C-200 undergarment. For hands, our solution is a thin wet suit glove called the Thunderwear and what we call a gauntlet glove. The hand part of the gauntlet breaks away and the diver has the dexterity of the Thunderwear glove. When you no longer require that dexterity, you put the glove part back on your hands to keep them warmer for a longer period of time.

We've tried the dry suit gloves; they don't handle the abuse well. They work well while they're dry. Typically we'll wear a wet suit glove under the dry glove just in case the dry glove leaks.

For our feet, we wear C-200 through C-600 Thinsulate with our dry suits. We have actually replaced dry suit boots with a bigger size boot in order for a person to wear the C-600 underwater garment.

For Phase I and Phase II wet suits you have two 1/8-inch hoods. For feet, all we have are 3/16-inch booties.

Adequacy of thermal protection. I've already discussed head thermal protection. A full face mask provides some thermal protection but it's not worn on all missions. When the open circuit/closed circuit crossover full face mask comes out, it will allow us to wear a full face mask on all missions.

The combat swimmer helmet and the DATPS are ongoing programs, but as far as I know they don't include head warming.

Hand thermal protection. Just like everybody says, the hands are the first part to become non-functional. Our dry suit gloves are good, but don't survive abuse. Thick wet suit gloves don't provide dexterity. So we use the combination gauntlet and the Thunderwear gloves. Electrically heated gloves are in development. Hopefully, that will be a solution, but they have to handle abuse. They also need to be relatively puncture proof and have a battery duration of more than 2-hours.

Feet thermal protection. C-200 and C-600 are worn with dry suits. If we're doing a cross-a-beach operation, typically the guy's feet are numb no matter what we wear.

CDR CURLEY: Mike, we're running behind schedule. You've done a superb outline for us—if you could just hit the high points and wrap it up.

LCDR WOOD: Okay. Land/water transition thermal protection is the biggest issue for us. In the water/land/water transition, typically the guys are warm when patrolling and then return to the cold water again.

The UBA is an issue on across-the-beach operations because we lay up our UBAs. We don't know the effects of lay up in cold weather or cold water on these UBAs. When you reuse these UBAs while transiting back in the water, the thermal impact on the diver is not known. For hydration, I have a list of concerns in the handout.

How do we rate mission performance? It's already been said if you can complete a mission, we consider it a success. I've got subjective and objective criteria listed on the handout.

Common tasks performed. Three mission scenarios along with common tasks are in the handout. Refer to those. To sum up a worst case scenario, I would include a 1-hour wait in the DDS, a 3-hour transit in below 40°F water, followed by up to 36-hour land

warfare mission in the low 40°F; then back into the water for another 3-hour transit in the SDV followed by a 1-hour wait in the DDS.

CAPT THALMANN: What would you say was the average time in the DDS during the wait period?

LCDR WOOD: One to 3 hours. An hour is on the low side. It really depends on the surface conditions. I'd say an hour to an hour and a half is a typical wait period. And that's from the moment that you flood the DDS. You may not even be under pressure yet.

MR. ROESCH: There is a disparity on your first page that says that you can operate in 42°F water with 100% success rate, but you've got mission requirements in 29°F water.

LCDR WOOD: I addressed that up front.

MR. ROESCH: Is that delta a significant? Is the need to go in 29°F still a driving need, or is that no longer the need that it was 2 or 3 years ago?

LCDR WOOD: That's above my pay grade to determine, but that operation plan is still in effect. It's still a driver for us. Even if that operation plan is no longer in effect, we still have North Korea which is relatively similar.

MR. ROESCH: So, you would still rate DATPS a very high priority for use in 29°F or at least colder than 42°F?

LCDR WOOD: Yes. And, if nothing else, to make what we are already doing more comfortable.

DR. DOUBT: Thank you. Is there somebody from SDV Team 2? No? Well, then we will hear from Lt Hart of the Naval Special Warfare Development Group (NSWDG) group.

NSW DEVELOPMENT GROUP

LT HART: I'm going to cover some of the issues that have been brought up by a number of the SEALS at the Development (DEV) Group. These individuals that have compiled the material in my handout go all the way from team leaders and operations bosses down to some of the junior members on the teams.

At the DEV group, we have a lot of training environments as we cover a lot of different areas and a lot of different techniques. In development and training we find the primary areas of exposure are in parachute operations, boat operations, over the beach operations, diving and reconnaissance, and surveillance training.

The air temperatures in each of these cases are going to vary, obviously, because the areas of operations differ as well as the time of the year. We find temperatures below freezing to high temperatures experienced in the Saudi environment.

Typically we operate in the Virginia Beach area, and that will give us a temperate climate—a relatively temperate climate. Water temperatures are going to vary from about 35 to 88°F. This range primarily affects us from the standpoint of boat operations, over the beach operations, and dive evolutions.

The number of air/water, land/water, and water-to-land transitions are variable. We can find somewhere between zero and three transitions per training evolution. The lengths of exposures to the environmental factors are going to be dependent upon which environment we're working in. In parachute training, for instance, they open up the aircraft and you're sitting there waiting for your Drop Zone (DZ) to come up and then you'll go ahead and jump. It takes usually a couple of minutes. But in HA/HO and HA/LO, high altitude/high opening and high altitude/low opening, we can get some pretty extreme temperatures, −20°F up to a normal operating temperature of 58°F. At high altitudes these exposures can last for up to 15–25 minutes.

Boat exposures. There's multiple different craft that we use. Exposures can be anywhere from a few minutes to several hours in duration, with a median time of approximately 3 hours. Over-the-beach operations, the OTBs, can last from about a half an hour to 3 hours in length, but those are very variable as well.

Dive training is typically restricted to Draeger use. So we're limited on our depths, as well as the duration of the canister itself. When the Reconnaisance & Surveillance (R&S) teams are doing training operations, they can be practicing a few techniques that could take anywhere from a few minutes to several hours. They may also go out in the field and spend days in whatever the environment is at the site they're working.

Our thermal protection basically follows what you've heard already from other individuals. It's mostly dependent upon the individual user experience; what they thought would work; and what hasn't worked for them. We have a lot of senior individuals, so they've gone through some of the mistakes early on and bring knowledge to the DEV group. We also have a research development team as part of our role that allows us to identify problems in certain areas—thermal, equipment, whatever. Identified problems are brought to the research teams; and then they will try to find solutions. And if one individual wants to buy a new piece of equipment, they look around and find what they think might work. They either test it on their own accord, or try it out with the guys in the team. If that's not exactly what they need, they'll go ahead and bring it up formally for testing by the research and development teams.

As a rule, individual preference will be the primary determinant in what they use.

Some examples of what we use for the various parachute, land training, boat, and diving evolutions are in the handout. In the land training, we stay away from wet suits and things like that because we don't need to use those garments. We'll look for GoreTex and field jackets, that type of thing to cover us.

For boat and diving evolutions, however, one of the things that they wanted to strongly point out was the fact that dry suits are great for the surface. They're great splash screens; they keep folks warm riding in boats; in fact, the guys that spend most of their time driving boats will wear dry suits or an exposure suit when it's cold.

However, when they do underwater operations, they will still opt for using wet suits. That's based, though, on shorter exposure times, not like the 8- to 12-hour exposures with the SDV Teams.

For head, hand, and foot protection, we basically use readily available items. Multiple types of hoods are worn, anywhere from scarves to two layers of wet suit hoods plus a hard helmet. Hands are going to need gloves. Protection ranges from a neoprene diving glove all the way down to fingerless leather gloves for manual dexterity to deal with weapons and controls. Foot protection will vary from the different types of boots that are readily available out there to just booties and neoprene overgarments.

We don't have the cold problems typical of some of the other teams. We have them, but they're not becoming a factor. Effects of working conditions and training or performance is from the collective memory of many operators. Conditions don't have significant influence on go or no go decisions during training evolutions. Whether or not it's warm or cold, they'll just do their job and get it done.

Consequently, they assess that thermal protection measures are adequate for the majority of our training evolutions. Of course, if they get an opportunity to dive in warm water versus cold water, they're going to pick something that's more comfortable for them. So, they'll train in the more idyllic settings.

Some of the comments range from "Yeah, I get a little cold" all the way to one team leader saying, "We border on putting on our entire element in hypothermia," with people being non-functional. It does not stop an operation or a training evolution, but they may have significant decrement in their ability to focus on the task at hand and being able to physically complete a task.

As far as the success of a mission or training evolution, it's usually a go or no go. That's what they're looking at. They're not looking to see how they felt while they were doing it, they wanted to see if they accomplished the objective. If they do, that's sufficient for them. In the post-operation reporting, they will address the fact that a piece of equipment did or did not work; or a technique was better than another one. They won't address items like what should be worn or what should not be worn; what kind of equipment

can we take. They make that kind of a decision on an individual basis.

One other interesting point is even if there are things that are brought up in a particular type of training evolution, these things will not necessarily be carried over to the next training evolution, even if it's only a month later. They forget.

Some of the specific considerations important to parachute training relate to high altitude problems. It's necessary to have the manual dexterity to control toggles and just withstand the cold temperatures for that 15- to 25-minute descent time. If it's extremely cold, they have some difficulty with hand and feet control of the parachutes.

Boat evolutions. One of our worst ones "for the record" has been scenarios in the Arctic. The boats will be covered with an ice sheet making it very difficult to hold onto anything, making it very difficult to stand, and weighing down the craft so that it doesn't perform as well. That is coupled with a long transit with water spray; the subsequent wind chill factor of high speeds; and then having to go into the water perhaps to do the OTB. They'll go in under the water, cross a surf zone, and then immediately face the wind chill factors of being exposed on the land. Their biggest complaint is going from being wet, then having to stand up and do prolonged treks over cold land terrains and wind.

The diving evolutions are really not that much of a problem for us. We do have some long transit times, but the diving itself is not bad. The transit times may lead to fatigue and cold. The only other kicker is when we finish up and get to a training scenario site. We can spend a lot of time, perhaps on a derigging line and sitting around and waiting for everybody to make it to the site. It could be anywhere from an hour to 2 hours before they finally would say, "That's enough. We're going to go on without you guys."

The final scenario is the R&S training teams. When they're testing and developing the various methods that they use, they're going to be out in whatever is the ambient temperature; it could be rain, dark, or snow. They'll stay there for however long they're expected to. They have to deal with cold and nutrition issues as well. They seem to survive fairly well. No one has gone out in the field and had to come back part way through these evolutions. Obviously very stoic and try to complain very little.

CDR BUTLER: Again, for the record, with regard to diving evolutions, your worst-case water temperature and duration.

LT HART: The worst case that was reported to me was a comment about spending time in 35°F water with wet suits on, waiting for a derigging line. They weren't specific about the time, but they've talked about times being 1-2 hours sitting in one spot.

DR. DOUBT: Thanks, Brett. The next presentation is from the Training Center and Lieutenant Commander Keith.

NSW TRAINING CENTER

LCDR KEITH: Hi. I'm attached to COMTRAPAC, San Diego. I'm here representing Naval Special Warfare Center. The Center's responsibilities in training are at the very basic level.

As most people in attendance are aware, our biggest course is Basic Underwater Demolition/SEAL, or BUD/S. We do teach a variety of advance skill courses, but these courses are designed to introduce students to SEAL skills rather than any specific thermal exposure. BUD/S students go through thermal stress in many evolutions. The level of thermal stress is administratively controlled by the instructor staff. Some portions of BUD/S use thermal stress to test student motivation. This stress is stringently controlled so that students do not get into situations that can't be controlled.

Air temperatures in San Diego range from the low 40 to 90°F. Water temperatures in San Diego and at San Clemente Island range from 50 to 75°F. These temperatures represent a moderate range; they're not the extreme temperatures encountered at operational commands. From a control standpoint, the center does not experience thermal variations which limit training scenarios. We do have problems, of course, from individual students, but these are things that we try to control. In 1987, we had a death due to hypothermia at San Clemente Island which caused us to change some of the ways we do things. We do now control more rigidly what students wear in BUD/S training as far as wet suits and water protection.

The current cut point at BUD/S is at 60°F level. Students wear wet suit tops above 60°F and wet suit bottom and top when the swim will last longer than 2 hours, or when the water temperature is below 60°F.

The Center is beginning to provide training in Military Freefall. As part of this course students can encounter extreme cold temperatures at altitude. However, it should be stressed that this training is administratively controlled. That is, if conditions are such that students' safety cannot be assured, training can be stopped. Additionally, students in the course are assigned to operational SEAL commands, and may use whatever thermal protection they need.

As far as the Center's extremes, the surface swim conducted in the winter months would probably be the worst cold immersion scenario. Water temperature can be in the low 50°F; swim duration can range to 5 hours.

The Center conducts SDV training in wet suits. We have a very minimal introduction to the dry suit in SDV training, SDV school, but the majority of the students currently wear wet suits exclusively; dives seldom exceed a 2-hour time frame. Planned changes to the course include an introduction to dry suits.

That concludes my briefing. Are there any questions?

CDR CURLEY: Who sets the standards for training regarding thermal protection and exposure? Who on the staff does that, or do you go to outside sources?

LCDR KEITH: Standards at the Center have been a judgment call based on years of experience. Following the hypothermic death, the Center was directed by NAVSPECWARCOM as to the level of thermal protection students were to wear for special evolutions.

CDR BUTLER: Where did they get the standards?

LCDR KEITH: For the most part, it was a judgment call. Medical advice was sought from available sources.

DR. GOFORTH: There were recommendations made and an investigation made.

LCDR KEITH: That's correct.

DR. GOFORTH: I was called in the last few days of that investigation and provided recommendations for wet suits to be put on the legs and/or the top anytime they're going to put a man in that temperature of water for that length of time. There was also a flight surgeon who had given recommendations and John Sterba had indirect input.

CDR POLLAND: I was not there at that time, but I would like to say that the Command had failed two previous inspections for the direct oversight of not putting enough medical officers down there. That death pointed that out, and as a result of that death, there were a number of significant changes which occurred relative to the 5-mile swim. We've been able to come up with guidelines which now are very specific as to what you're suppose to wear in what temperature of water and what length of time.

When we get a hypothermia or hyperthermia incident, it's reported to the Command and changes are made if needed.

DR. DOUBT: You have these standards, but what criteria do you use, for example, on a 5-mile swim? Do you monitor the swimmers and say, okay, we're going to pull this guy out and we're going to stop this evolution irrespective of the individual's motivation? What do you look at to say that's enough?

LCDR KEITH: The individual's swim buddy is the primary person who's responsible for evaluation. There are instructors in safety boats following swimmers throughout the swim. They react to any type of problem or symptom they encounter, or to anything identified by the swim buddy. If it appears that an individual is having problems, he's then evaluated more closely by an instructor. A decision is made whether to pull him

from the swim or let him continue.

DR. DOUBT: To follow up, what kind of things do you tell the swim buddies to look for?

CDR POLLAND: If hypothermia presents, often the guy is not going to stay in the pack; he's going to fall behind. The dive buddy is then supposed to start asking questions of his dive buddy. If the dive buddy isn't appropriate in his response, he has the task to raise his hand. An instructor will come over in a kayak at that time, and if there is any question, that guy is taken out of the water right away.

Furthermore, there's a doctor on the beach paralleling the last half of the 5-mile swim. We've never been able to identify anybody having problems during the first half.

DR. DOUBT: At this point, I would like to see, by a show of hands, anybody that would like to bring up sensitive issues that will not be part of the recording. Are there any particular items related to thermal protection or performance that need to be unrecorded. (none)

Then, I would suggest that we move to the round table discussion and address the question, "What do you want from us?"

ROUND-TABLE DISCUSSION

CDR CURLEY: Basically, this is an opportunity for the teams and the operators to ask, "What should we provide you in the R&D?" "What are your present concerns?" We'll make this an informal brief to begin these discussions. Just throw up some items that you think would be useful to you. Yes?

CDR BUTLER: I think in focusing the discussion I want to bring up a point. We have many guys here who know an awful lot about thermal studies, about thermal protection, and we have the team representatives here who are familiar with the type of guys they have back at their commands. The issue is how do you get the information from NMRI, from NHRC, from the other activities, from me to you and other places that the studies are done, back to the teams? Not sporadically—not just if one's command happens to send somebody to the Naval Special Warfare R&D Conference because most of their representatives are here. We see some of the problems reflected here even with travel funds paid, even with commands 2 miles down the street at Norfolk. It's tough to get people out of an operational SEAL Team to show up to these kinds of meetings.

So, we have to get the information from the lab to them and we can't expect them to come to these kinds of meetings and take part in these discussions. And, now we have to figure out how to make the information readable and useful. I think that's the course of what we're trying to do here and we need to hear from the team guys about this.

OSCM JARVIS: Part of the problem we see at our command is not so much related to thermal things, but all kinds of issues—explosive devices, this, that, and the other. They'll solicit input from people that attend these meetings, but even if the information is available, we're more interested in products than in information. I mean, it's helpful to know that you could eat certain things and help to stave off hypothermia, but the problems that we often see are the things like leaky dry suits.

So, a lot of times the equipment will work fine. You try it on at a shop and get into a dip tank and you say, "Yes, this works great." But after about 3 months into it on deployment, and when that thing falls apart because it's poorly constructed, information isn't what's lacking, but rather, durable equipment.

CDR BUTLER: As an example, if somewhere down the road we come up with the DATPS, the greatest dry suit or the greatest wet suit ever to hit the streets, in what format would this information have to be to convince Master Chief Jarvis that this is the dry suit he wants to use? How are we going to get that information to you, and get you to get that to your sailors?

OSCM JARVIS: That's a good question because a lot of times, you'll see specifications written that say it can stave off cold for so many hours; it will retain heat so well. It's not worth a damn if this thing leaks.

CDR BUTLER: Most of those kind of things are fantasy, you know. You guys need objective data that you can't get from the local dive shop.

LCDR WOOD: One of the products that I would like to see from this conference is in the form of information coming to the teams. One, basically just a general listing of ongoing programs and studies and a list of reports that are out in particular areas. Maybe that 52 to 15 type format has already been promulgated and I don't know about it, but I'd like to know if a list of all of these reports are available so if we at the team have a problem in a particular area, we look at this index and say, "Hey, here's some reports from this particular area. Let's look them up."

CDR BUTLER: I think that's a great idea. I have a copy of exactly what you're looking for here, and both of those two things specifically are currently in a letter that's at WARCOM being stamped to be sent out to all the commands. The problem is that if you look at those letters, those things are written in technical jargon making them incomprehensible to somebody that doesn't have a Ph.D.

LCDR WOOD: Yes, that was going to be the second part of my comment on this. I'm only using this as an example, so this is not a negative comment. A NMRI report on "Preliminary Guide and Hydration Guidelines" was fairly readable for a layman like myself, but is there any way of bulletizing actual bottom line information in a report? For example, after reading quite a few paragraphs here, I get down to the areas that are underlined and they state, "Ingesting 250 ml of either water or a commercially available glucose solution

each hour during the 3 hours of resting immersion at 35°C water, did not improve hydrational status." Now, I'm not taking this out of context; please don't get me wrong. But, I would like to know is it possible to get bulletized bottom line comments out of reports?

CAPT THALMANN: Did you see the cover letter that came with that?

LCDR WOOD: I may have; I may not have. That's a good point because that comes to us from all the different labs. I had a certain report from one R&D lab that came out to me in the Gulf. It had to do with another subject regarding mines, but the point is, it gives us the bottom line information and, hopefully, nobody's going to sue.

CDR BUTLER: Well, what we're looking at here for the next 2 days is exactly what bottom line information that we want you guys to get. What information you want, what information you can understand, and what information is useful to you.

CAPT THALMANN: Just put down how you would have liked the information out of that report.

DR. GOFORTH: Two things. One, on this carbohydrate question. Our lab actually went to the submarine that the platoon was going to go on board. We took the 21-day meal cycle that was approved by Food Services and we just gave the SEALS the menu. We said, "Here's the meal. Give this to the cook and these are what we recommend." That's how we boiled it down, rather than put it in grams or carbohydrates and all of that stuff.

But, on the issue of how do we get this information back, we've also tried to be part of each AOT platoon training at SDV Team 1. We let them ask us the bottom line issues regarding questions about thermal protection. So one way we get our information back to that local command is post-mission. We've also made a video which is going through some editing which can be made available to the East Coast teams.

So, standing in front of both the basic SDV Teams, or class and the AOT class, you'll be able to effect some change. I was proud of the way that Mike presented such an extended list.

CDR BUTLER: That is going to be expanded. I was struck by exactly the same thing that you were. The difference between what came out of SDV Team 1 and the real depth of knowledge reflects NHRC's effort. I think we need to expand this effort to the East Coast because we can forget about the guys that don't live next door to NHRC.

To me, we need to make some changes in the information that we present; we want to focus it precisely. When we come out with this new information, we have to make sure that this information is presented not with big grasps of heat flux and those kinds of things, but the bottom line. What the operations folks tell us in the next day and a half is the bottom

line. And, when we have transfer seminars, we need to focus on "What do they want to hear?" "What do they need to know?" "What's going to change their mind from the Phase I/Phase II to a dry suit or the other way around?"

LCDR LAURIA: The mechanism to transfer this to the command is to print up either a TAC memo or some sort of handbook and have that come out of the Warfare Center's strategy and tactic section. I know a lot of team guys like to get hold of their own copy of a book. It doesn't have to be a formal TAC memo, just a small pamphlet of some kind, 10, 15, or 20 pages, whatever this turns out to be with the guidance that's developed. If that's distributed throughout the teams and it comes out of the Strategy and Tactic Center and it's part of the training, that's his guidance.

LCDR WOOD: Actually, I'm thinking about getting it into *Blast*. Seriously, what media or documents do you guys read more than anything else? Are we talking the *Blast* or the new newsletter that's supposed to be coming out from WARCOM—full mission profile? I don't know, but are typed memos distributed in the Teams or is there only one or two of them?

LCDR LAURIA: TAC memos are not the way to go; rather a smaller handbook type that's low cost for printing after you get enough out to everyone.

LT KASEL: Exactly my point. The Army has something small like a GTA card. You know you can make stacks of them. Something simple like you're saying, in that everybody has GTA cards, as soon as they see why they've got to have them. And if we can have something simple to give us some guidelines, we'd have to make a lot of them as sets for SDV guidelines. They can be handed out easily and distributed generally.

HM2 PAPPAMIHIEL: The problem comes down to getting the information out to the guys in the platoons. Part of it is the SDV Teams get a lot of attention because of their durations in the extreme water temperatures. The other SEAL Teams don't get quite as much attention paid to them, but then they're not in the water as long. We don't see the results from a lot of these tests and what these guys are saying about simplifying things is right. We need to have ways of evaluating the equipment that we do get that's simple, and that the guys can complete in 5 or 10 minutes.

You know, after an operation, the men could sit down with a sheet where they can check things off—"Yes, this worked fine;" "no, this didn't". That would be very helpful. Also, we need to get the procedures to the guys to evaluate themselves out on the operations. Now, that happens probably not as much as it should. We need to have the guys who are going to be out doing that testing and evaluation of the equipment.

And, one thing that I and Lt Kasel are uniquely qualified to talk about is these medical issues. It's something that's being readdressed now, and it's getting better. The training that corpsmen have been getting in the past to handle these situations has not always

been sufficient. If the corpsmen were given the ability and the training to submit reports where everything is standardized, some of this information will probably answer the questions you medical folks are posing.

CDR POLLAND: It's a communication problem as I see it. For example, I remember in the mid '80's we were working with Hal Goforth and people at the NHRC. There was information being passed back and forth. You've already talked about that.

The other thing that I thought about was that there is already an attempt to try and find a better article to do the job which they're trying to accomplish, either through their R&D efforts or through their going to a little dive house to find a pair of gloves that will work for their jumping and diving. Sometimes these things get past; they may have worked for one area, but they didn't work for somebody else, and somebody said, "Well, that's a piece of junk." For example, Fleming who actually discovered penicillin in the '20's didn't relay the language until the 40's.

It seems to me that what is needed is a person to collate and refine the data which currently exist. They need to look at what's happened in the past and make certain that we haven't passed over something that maybe did fail in one area, but it could have applicability in something else.

Getting back to what Mike Wood said and what Dr. Butler talked about, we need to develop an effort to try to reduce this task down to something that's workable. If a small publication had a grid in it where you could look down and see what's in the article, and where its applicability is, that might be helpful. Then, a guy can look at it and he can mix and match it.

I have one more comment that's relative to what was said about corpsmen training. The corpsman training issue has not been revamped entirely in the Navy for SEALS, and in '91 and '92 we're in the process of converting that. I think for the next few years, given the generic corpsman training which is in '92, we must get that on board. You will see a change—a great change.

CDR BUTLER: Going back to your idea about the grid. If you could be thinking of what we've talked about right now, we are envisioning a simple grid, one of which would be produced after each of these research studies. For example, we looked at the depths; we looked at a new dry suit; we look at whatever; each of these studies generates a simple grid and then every year, every 2 years, maybe every time you do it, you put it on a GTA card. Accumulate these grids and get each grid out to the teams, so if they want to go back and say, "Well, gee, you know, the West Coast guys are using this item and it looks good."

LT KASEL: We need to talk to platoon members, talk to the guys who just came back from deployment. Debrief them 15, 20 minutes each time, asking "What worked for you?" "What did not work for you?" "How did your boots work for you?" Ask simple

questions which almost could be answered by yes or no. Some of these guys during Hell Week were able to do that 5-minute question at the session and find out: "Are you cold?—yes; Are you shivering?—no; when was the last time you shivered?—3 hours ago."

You can ask the questions quickly. If you come and do that to a deployed platoon while it's still fresh in their minds; you can set them down and do a post-operation. Then you start developing these things—"Did your gloves work?" "What kind of gloves did you use?" For example, that was a topic that every single person here talked about: gloves and boots and headgear.

We're not talking to each other, team to team, on what's working and what's not working. I know that SDV Team 2 hasn't said anything to my SEAL Team 4 about cold-water operations. Communication among the team members would also help improve knowledge.

LCDR WOOD: Regarding that grid, I think that's a real good idea. I think that goes along the same lines of developing an index of available ongoing programs and reports. In that grid, though, to determine whether or not that same situation applies to you we need a list of lessons learned or history behind each problem. For example, Doc Goforth mentioned the satellite affair which was dry suit, Mark XV, cold-water related. If a short history of something like that was mentioned, then another team member that looks at this report might say, "Oh, cold water, I can go to that report," and he'll look at that affair and he will see that it was Mark XV and SDV related and he can stop right there and say, "Now, that doesn't pertain to me."

CDR BUTLER: Correct me if I'm wrong, but right now in our community, we have no place where those sort of accident reports, after-accident reports, or incident reports of any type are maintained.

LCDR WOOD: Right now, JWLS reporting in the long run might help that, but for example, SDV Team 1 does SDV after-action reports after every dive and we address equipment items, but those go to a nebulous hole in a safe somewhere and die on the vine. So, if there was a standardized reporting format—

CDR BUTLER: Well, it wouldn't necessarily have to be a standardized reporting format, but even if we were able to figure out how to get all of these things to WARCOM or another appropriate place, we must keep them available for future reference and not locked up in SDV 1's safe.

LCDR WOOD: All these lessons learned and after action reports were supposed to be filed so any platoon commander or any team could jump in that computer and refer to those files. That never materialized as far as I know. I believe a go-getting type platoon commander would want to look up lessons learned in post-operation reports to find out what problems there were, but in reality, there is no avenue right now for this information. JWLS

doesn't do that for us because that deals in exercises and all those other things, whereas daily dives and training missions don't get reported anywhere except at the individual team.

LT KASEL: There is a standard Navy form. Going through all these actions, we just have little things; you turn a report in and you get it sent back saying it's not important. That's why we don't handle them. We don't want to take this one. And, along with JWLS reporting, it's great if you're at WARCOM or on the West Coast, because that's where everything ends up. We need to get this computer system on line where I could go up to SEAL Team 4 and punch it in; right now we don't even have the disks to put everybody's post-action reports on one disk. Then it's supposed to go up to Group, where Group is supposed to maintain all these files from SEAL Team 8 and SEAL Team 2.

Right now, it's still only what's in that great safe that's locked in operations.

CDR BUTLER: The concept I'm thinking is if the information comes in from SEAL Team 4, you send it to me or whoever coordinates this from WARCOM; we enter it onto a computer, and we send it back out to the teams maybe every 6 months or once a year. We take what all the teams have sent in and turn it around and send it all back out. I mean, a disk isn't that expensive.

LT KASEL: But the problem is we only put post-operations from exercises and deployments. You know, last week when we did our dives in water, nobody asked "How did everybody feel in the water?"; nobody knows. If anybody says anything, it generally doesn't get reported until a death or major injury.

CDR BUTLER: I think for the purposes of this conference we're going to have to maintain a focus on medical and physiological issues. I'm thinking to make this useful in this format we must be unclassified. If we start talking about classified tactical post-operation reports, then all of a sudden it's going to get eerie getting it back out.

LT KASEL: I think your best bet would be talking to a training department at each team, or the operations training officer. Give a simple form to the trainers so when they're out there training, if someone says "Damn, my hands are frozen," we can talk about the cold weather. When you're operating in 60°F weather for 3 hours, there's not much that's going to happen to you; but when you start pushing those parameters to both ends, that's where our accidents seem to occur.

If you had a training department and a simple form for the training department (not the operators themselves), they could do an actual debrief like pilots do. They seem to debrief every mission, but we don't debrief our missions. We go in after the operation; the general scenario goes, "Yes, we had a good time here. We had no problems here. Any questions? Any comments?"; and it's over. If we had something separate from the platoon taking down some notes on the subject here, "I had problems pulling my pins with my limpet because my hands were frozen," it would be beneficial.

CDR CURLEY: You've identified a number of key issues and we've got them down: usable information from the lab; communication among the different teams; assisting in the ongoing programs. "What's the bottom line?" interpreted for me. I think this information is within the command and there are simple ways to obtain it—performance post mission, during the mission. Train the corpsmen; facilitate communication; look at the past research.

Now, considering that we are in a thermal workshop, what other information do you require? We've talked about communication, but is there any other specific information that the teams need regarding thermal and performance issues?

Do you have any questions that you want to bring forth that we could take back and address?

OSCM JARVIS: Buy NBC equipment. NBC got a lot of people's attention during Desert Shield/Desert Storm, but nothing has been addressed to us as far as anything that's come out of that. We need to be able to work that environment, too.

And, we've also got to worry about getting our equipment wet. Every time we've done the gas-mask drills near the water, the filters get wet. That's just one more problem that we face in addition to the problems of heat stress.

LCDR KEITH: Apparently this is a bootleg copy of an insulation grid. Would you give this to LCDR Presswood?

CAPT THALMANN: I'd like to see something similar to this available to us and also a list of equipment with their clo values. Each team has different requirements and different missions and if they know what they're going to be wearing on a particular mission, they can go to this list of equipment with it's corresponding clo value (if that's the appropriate term) and look at their operating temperatures. This grid is presented, I guess, in a range. It says a minimum and maximum on that and gives the likelihood of success in utilizing that equipment.

CDR BUTLER: All it has is the equipment being provided us. You said you wanted a list of all thermal protection gear that was currently in use and that's the only response we got. It will be interesting to see whether they think it's useful or not useful. I have a feeling that the first reaction from a guy sitting at a table and looking at it will be to say "Nonsense, I can dive in 45°F water in undershorts; I do it all the time." So, we'll see.

LCDR WOOD: I'd like to see that in a water scale. We're talking about land/water thermal issues as well. I was just wondering if that can creep over into the land side of this. In other words, we've mentioned poly-propolene and we've mentioned GoreTex and we've mentioned all these other things.

Honestly, this started out as a diving thermal workshop. We have to go beyond that

and start to look at transitional situations. And, we are taking notes, yes.

CDR BUTLER: It's a diving thermal workshop, but you asked us about our transitions.

OUTLINE OF SESSION OBJECTIVES

DR. DOUBT: The first session this afternoon is the round table discussion on the thermal measurements. I remind you, again, we really want to talk about the measures and not the measurement techniques. Keep in mind that directly or indirectly those measures would have to somehow be translated to something useful for the operational people. Dr. Goforth and I will direct the discussions in areas of objective measures, and the direct and indirect thermal measures.

THERMAL SESSION

DR DOUBT: I've put up a list of objective measures which provide a general starting point.

To begin, age of the diver. Age is self-explanatory. Down the road, age may be used to sort out who should dive in warm or cold water.

Is it important to document the amount of NSW experience that an individual has? Is it years out of BUD/S, years with SDVs?

CDR BUTLER: Are you still thinking a single sheet to summarize that entire set of exposures? Would summaries have just the average age for the entire group?

DR. DOUBT: That's a good point. Should it be the average age or do we report the age of every individual involved in this particular study?

LCDR WOOD: I think if this thing is for a matrix for an individual diver, it might be an issue. If it's a matrix for the group conducting the mission, I don't know whether age is going to be a factor. I mean in one platoon you could have a guy that's 21 and another guy that's 42. You can average it out.

DR. DOUBT: You could average it out for the range.

CDR POLLAND: If there has been a problem, then specific age would be more relevant than just an average. I feel age is certainly important. It's an absolute limiting factor for some people in some cases.

CDR BUTLER: On the other hand, has age been shown to be a determinant in a person's thermal stress tolerance?

CDR DOUBT: True. It's been shown for the extremes of age.

DR. BUTLER: Twenty one versus 35?

DR. DOUBT: That, I think, is less clear. The smaller the age range, the less you would expect to see group differences.

DR. HYDE: There are some very specific changes that take place in mechanisms of heat dissipation or heat conservation as a person gets older. I don't know that we can definitely say that 21 versus 35 will produce "x" percent change.

CDR BUTLER: We have to understand that we're not excluding that from the report. When Mike Wood looks at this to decide whether this dry suit is better, is age really going to be that important?

UNKNOWN: Are we talking about a report summary or are we talking about the report?

DR. HYDE: I thought we were talking about the individual mission report.

DR. DOUBT: What I think we're talking about is before you undertake a training evolution or a study, is this going to be a piece of information that you need to conduct your mission. Within the body of the report, for example, you can break down individual ages.

CDR POLLAND: The way to answer your question is through an asterisk, that is to say, that age may be of relative importance if it's at the end of the envelope. If the guy's middle-aged, he's a CO. If you take the Commodore on a dive you might have to consider age. Maybe that's the extent of it.

CDR BUTLER: How about some input from the team guys? When you start to look at these, assume that these are going to be excerpts from a report to get bottom-line information to you. We don't have to belabor age too much. Bear in mind that we want to limit the total amount of information to really crucial items. Which of these things will help you guys?

LT KASEL: First you look at experience. I can think of an 18-year-old and a 42-year-old who were in my platoon. They were diving partners. I'm a little more worried about the experience level than the age level, personally.

LCDR WOOD: Are you talking about this information going into a report or is it going into a one-page matrix?

CDR BUTLER: A one-page matrix. Don't worry about what goes into the report. That's still going to be left to the guys doing the research.

LCDR WOOD: Then, I would say age is unimportant. If he's too old in the first place he won't be in the platoon.

DR. DOUBT: Is it generally agreed then, from the teams, that age is less important than experience.

(Several people reply "correct")

Now, what kind of documentation is important to know about experience?

LCDR WOOD: Years in the specific field. If I get a SEAL to come to the SDV team who has 20 years in SEALS and zero years in SDVs, he may have a lot of experience but he has limited SDV experience.

CDR BUTLER: How about cold water experience?

LT HART: Being in either a SEAL team or SDV will help determine that.

CDR BUTLER: One of the problems that pops up relates to lab studies. SEAL teams don't want to send 20 guys for 6 weeks to support a lab study. The lab's going to get other divers. These other divers are going to be a mixture, first class divers, second class divers, EOD. So how are we going to rate NSW experience?

LT HART: Zero.

DR. DOUBT: Could we make it a check box?

CDR BUTLER: If we just say zero for a guy with 12 years diving experience, I'm not sure that really translates to the right flavor.

MR. DUDINSKY: That's a useful piece of information in and of itself though. Including both years of experience in cold water and SDV exposures would give you a better relative indicator of experience.

CDR BUTLER: Or for that matter, fleet diving experience versus NSW experience, just categorizing the type of experience.

DR. DOUBT: To help you, then, so you need to know whether the people in a report were NSW qualified, or whether they were fleet SAT qualified.

LT KASEL: If he'd been in SDVs he's been cold, period. You know that. You don't even have to think about it. A fleet diver has probably been cold too. We can generalize those. All we need to know is if he has spent 4 years as an SDV, 3 years in the SEAL team, and 8 as a fleet diver. We then have a pretty good idea of what his experience probably is.

DR. DOUBT: Will putting that on a one-page summary be useful to you as opposed

to the body of the report?

LT KASEL: I don't think so. I look at my experience and whether a new guy has got 12 years in the Navy. I look at that, personally.

DR. DOUBT: The issue was raised about body composition. We know from a research standpoint that body composition is extremely important. Fat people stay warmer in cold water than skinny people. At rest, muscular people stay warmer than less muscular people. I raise the question then, is some measure of body composition important? We agree that it's an important measure. The harder question becomes one of which measure? In a laboratory setting we could do many kinds of measures, but in field studies there are fewer options. What's most important? I think we can probably exclude hydrostatic weighing. Most teams don't have an immersion tank or bio-electric impedance. One option would be to measure skin-fold thickness as a measure of body insulation. From a research standpoint, that is important. The question in my mind, is whether you measure skin folds in the field.

LT KAUFMAN: I think most of the people know what they are. We have some annual testing that says what our body fat is, and it's not going to change.

DR. DOUBT: But, if you broke your leg right now and 6 months later went back on active dive status, you may have gone up to 12 or 14% body fat.

LT KAUFMAN: I think most people are aware of where they stand to their fitness.

CDR BUTLER: Now, you're talking about the skin fat that they use by measuring the neck circumference and the waist circumference?

LT KAUFMAN: Yes, sir.

CDR BUTLER: My impression is that's way off.

DR. DOUBT: In terms of body insulation and tolerance to thermal stress, the tape measure is probably as good as your thumb.

DR. GOFORTH: Jim Hodgdon of the Naval Health Research Center (NHRC) would take great exception to that. NHRC calibrated the tape measure against in-water weighing values, and found that it was good within a couple of percent and that's why the Navy uses it. However, the way it's applied in the field depends on whether the corpsman wants you to cinch that sucker down or let your neck puff out. So you may have a good corpsman and your measure may be good. You know yourself, that if the tape is cinched down, the values won't be that good. The scientist taking the measures can apply, in my opinion, either the skin fold or the ponderal and be plus or minus 2 or 3 percent.

LCDR WOOD: That information gets us close enough to make a decision on what garments to wear. It may not be totally precise. We've proven that real skinny guys just don't make it on the full missions. The only way I can qualify that is by going to neck and waist measurements.

DR. DOUBT: Alright. So, you think that the tape measure is more useful and can be applied both in the lab and in the field?

DR. GOFORTH: As you know, to become qualified using the caliper takes a thousand or more measures. I doubt that each team has somebody with that level of experience.

CDR BUTLER: I think there's no doubt from listening to the operators that they understand the importance of body fat composition, however we measure it. The team guys will never be measuring this stuff. All of these measurements will be made by labs conducting the studies. These things will not be done by untrained people. That's not a surprise, is it? The quality control involved in having, for example, the SEAL team corpsman do skin-fold thicknesses or even tape-measure weights, makes it, in my viewpoint, totally invalid. It's up to you researchers to decide which of these methods you would most like to use. The teams won't be required to do this.

DR. GOFORTH: Maybe you SEALS could ask us what measures we'd like to make. Tom and I can agree on a list of measures and then get your comments. Is this a better way to format these discussions?

CDR BUTLER: The operators unquestionably are interested in body fat composition. They understand that it's important, but you experts should decide how that should be measured.

CDR POLLLAND: I don't think you need to really worry about doing a measurement on a neck and a waist. There have been people's careers literally gone down the drain in the Navy relative to this measurement. I'm also thinking about people who work out three and four times a day and come out over fat. In a case like that, all the diving medical officer has to do is certify that this guy can dive.

LCDR WOOD: I think I've lost the focus of what we're talking about. Is this to help me to decide whether I wear a C-200 or C-300, or is this to determine whether I'm kicked out of the Navy. That's why I asked about single-page matrix or whether we are talking about the whole report. I have two different answers for the questions you're asking me depending on the focus. If it's a report, I'd like to know some of that information. If it's a single-page matrix, then you're probably going to eliminate most of that. Is the operator going to use that matrix to determine what thermal gear to wear on a particular mission? I still don't understand where the focus is going.

DR. DOUBT: The focus is going in series with your comment. First, is to decide what R&D measures are important. The next step is one of translating that to a one-page format. For example, if it's important to you to know whether the guy is fat or skinny, all of the R&D labs make some measure of body composition. It gets translated to the bottom line that we talked about this morning, fat or skinny.

That's how I see it; agreeing upon measures and determining how they can be translated to a one-page format useful to the operators.

DR. PRUSACZYK: I would tend to go the other way if we're coming from the research end of it. Things like age are easy to collect, and you can always exclude things from the final report. There are also things we scientists like to measure that don't have to go into the matrix. For example, we don't know if a 21 versus 35 is different. How do we find out? We collect the data and look at it. If it isn't different, then we don't include it in the report if it's not important. You can always exclude but you can't regain data.

HM2 PAPPAMIHIEL: So, what you guys are saying is when we test a piece of equipment, we submit our findings on this piece of equipment. We're going to tell you how old we are, how much experience we've got. Is that what we're trying to do, to figure out how well this equipment works?

DR. DOUBT: It's only for R&D efforts. If you have a training swim you don't have to measure body composition and age for your platoon, unless it's tied into information for the R&D community.

CDR BUTLER: A couple of amplified remarks. It is important to reiterate over and over that this does not restrict the researchers in any way, shape, or form. Researchers can and should gather as much information in every study as they think is appropriate. What we're trying to do is put a filter on what they send out in this one-page summary of their project. At least some of the field studies will be conducted by one of the labs. So, the teams themselves won't have to send anything to the research labs. This effort is to help the labs to standardize some of these measurements for every study.

LCDR WOOD: So, if you have this matrix I would like to see the percentage of body fat regardless of how you got it.

DR. GOFORTH: Should we include height and weight?

DR. DOUBT: Yes.

DR. GOFORTH: The linearity of an individual has a lot to do with thermal response. I've seen thin people with 20 or 25% fat who are still quite linear. They have a high surface-to-volume ratio. A somatotype index should contain percent body fat, linearity, and a muscle mass component. That's what I use routinely. I could propose a measure of

percent body fat and you could respond to whether it's useful. Not all technicians are trained to take bone diameter measurements necessary to develop a somatotype index. But, that's just what Tom and I could discuss. This would give you three numbers, one for body fat, one for linearity, and one for muscle mass. Those get plotted on a somatotype chart. Those of you who have seen my talk, know you can see where you fall on the scale. There are people who have somatotypes like a bowling ball. They could ride around in an SDV in cold water for a long time. Others who are linear and have low body fat would shiver to death. Sometimes, I've been called on the carpet for pointing to an individual and saying "you're an ideal SDV operator." The guy would tell me where I could go, because he didn't want to be an SDV operator, he was a SEAL team operator. Nevertheless, he had a perfect body to ride in the SDV in cold water.

LCDR WOOD: When you categorize that thing, you divided it up into hockey players, all that type of stuff.

DR. GOFORTH: SEALS like to identify with competitive athletes who have similar body types. That's in there for information. It's not in there solely for research needs, it's just another SEAL descriptor. The wrestler and hockey player have somatotypes like the preferred SDV operator.

DR. DOUBT: If you use the somatotype chart on the one-page summary, you get a report that says this study was done with mesomorphs, muscular guys, fat guys, or skinny guys. It's a succinct summary of body composition that can be useful. It could be arrived at in a couple of different ways from the R&D community. Does that sound like a reasonable approach?

LT KASEL: I think you probably need age, height, weight, color of eyes, muscle mass, all that information for your research. As an OIC, what I want to see is years of experience. I also want the type of exposure, cold, wet, or dry; and whether it's diving or in the lab. Time of exposure is important to me as an operator. What you need for your information, that's your business. If you come out in the field with skin calipers, more power to you, because I want the best information.

DR. DOUBT: I think you've hit it on the nose. If we say we need this information, then we measure it. But we also have to take that information and translate it to something useful for the operators. Suppose we agree upon an index, and Hal goes to your team and says we want to measure mumbly pegs. Can it be done, are you willing to do it?

LT KAUFMAN: I will say very likely you can. An example of that would be when Dr. Goforth came in and looked for volunteers for bicycle rides. As soon as people found out there were going to be some real results given right back to them, they were beating down the door.

LT KASEL: Proper heads up is the key. If you walk through the door unannounced,

there might not be anybody there. It would take a little communication, talking on the phone, but I'm sure you could get the personnel.

DR. DOUBT: I'm reasonably certain that most R&D labs don't show up at midnight unannounced.

UNKNOWN: Well, don't be so sure.

HM2 PAPPAMIHIEL: If you came out and said, "Hey, we've got this piece of equipment and we think it will greatly enhance your ability to do your operations, we would like to test it," you're going to get participation.

CDR BUTLER: The issue is not whether we'll be allowed to do the research. I can help with that. The issue is whether we physically have whatever equipment we need at SEAL Team 4 in Puerto Rico to be able to make the measurement.

CDR POLLAND: I agree. However I think you need two things. You need the velvet glove that the Commodore will provide you, to say this is not a bad idea. The second is that you need to inform people and tell them why. We had a program down at BUD/S that people didn't want to get involved with. Researchers came in and told them a little bit more about it, and then they had to turn people away. So, it's a matter of sales.

DR. DOUBT: Water and air temperatures and depth of diving are pretty straightforward kinds of measurements that can be obtained without a great deal of difficulty. Should we include either the type of dive or the type of mission?

LT KASEL: Type of mission and type of exposure go hand in hand in my book.

CDR BUTLER: Many lab studies may involve either at rest or work/rest. If it's work/rest, we'll need to give what the work and rest cycles were. If it's something done in the field then it would be something more simple like compass swim or SDV ride.

DR. DOUBT: My feeling is that issues like what thermal garments people wore should include clo values.

The last thing I wanted to address was objective measures of thermal stress.

LT HART: Somewhere in the report we should categorize whether, at the end of an exposure, the divers were observed to be shivering. I think that's important information for the R&D labs. It's also, perhaps, important information for the operators.

One of the things that you might be able to do in the matrix is to put a term of hypothermic reaction on the back. You could list hypothermic categories. That way they don't have to worry about the particulars of which things generate mild hypothermia.

OSCM JARVIS: What do you consider mild hypothermia?

UNKNOWN: One of the beauties of shivering is that people understand shivering.

UNKNOWN: You're shivering intermittently or you're not shivering, and you don't have to read it on the back of the matrix form.

CDR POLLAND: Fatigue also comes in there. We've had guys that wouldn't shiver at certain temperatures or exposure ranges who had been out in the field for 6 days. At least, that's the interpretation given to us.

CDR BUTLER: You can get to the point where you're so fatigued and so thermally stressed that you don't shiver, but that's when you're almost dead.

CDR POLLAND: No, I'm saying you can shiver sooner if you're worn out from other things and not just the temperature.

CDR BUTLER: Most of these will be training operations so we can assume that the average SEAL's adrenalin level will be pretty low on routine swims.

UNKNOWN: As a medical officer, if I found out that someone observed someone shivering and then watched him stop shivering, and didn't do anything, and then a casualty ensued, the guy would be in serious trouble because it goes from being a research tool to a safety issue. That individual obviously has worsened if he stops shivering. So to answer your question, yes, it should be noted.

DR. DOUBT: I caught the sense this morning from some of the presentations that after-action reporting is not fully developed unless there is a casualty or an equipment failure. Therefore, should we incorporate into the R&D report some statements of abortion or difficulties within the mission? For example, SDVT 1 goes out and runs a training evolution. The guys come up on the beach and they do something. They go back in the water and it's noted that they forgot their Mark 15s. If they came back to the beach and got them and went on their merry way, it wasn't a casualty and it wasn't an equipment failure. But it's useful kind of information to report. How is the best way to obtain those measures, from an R&D standpoint?

CDR BUTLER: This would be something that would have to be done not as an after-action report, but as part of the study itself. That's really important. Let's say that you're testing a new dry suit. You're going to do 8 dives in this new dry suit. You say, these guys did great. There were four guys and their core temperature didn't go down at all. Their performance was great, they weren't shivering. You say, wait a minute. How come there's only four guys in the report? Well, the other four were aborts. Why were they aborts? Maybe because they were in 30°F water and their dry suits flooded. That's the kind of stuff you guys would be interested in, the reliability of the thermal garment and aborts.

LCDR WOOD: That can usually be provided by the team participating in the R&D study.

CDR BUTLER: The data will be there. The question is whether you want to see it on your summary.

LCDR WOOD: That's really essential if we're coming out with thermal guidelines, dietary guidelines, and planning procedures. We need to close the loop. You'll have to tell us if the item worked. Not only are you giving us feedback as to whether it worked, but if not, what needs to be improved.

CDR BUTLER: These will be tests where NMRI says we tested this dry suit. We did 81 dives, and had to abort 4 of them because the dry suit leaked. That's going to make the guys in SDV 1 less fired up about using that dry suit. The field evaluations are a different thing. This is, again, information coming from the research labs back to the teams.

LCDR WOOD: It seems the information has to go both ways. SEALS are not always going to be involved in R&D-sponsored study. But every time they go out they do choose a thermal garment. That's valuable information to us even if they're not part of an R&D study. If the guy got cold, what was he wearing?

CDR BUTLER: What you're saying is absolutely right, and it's a valid point, but it's not what we're doing. We're looking at specific thermal garments, so you can take that information and decide whether to use them for an operation.

DR. DOUBT: We want to focus, as Frank said, on R&D efforts and not on the collection of data every time somebody does a training dive. These R&D measures are ones that all labs would make. We will discuss tomorrow the central data base and the translations needed for a one-page summary for the teams. The agreement would be that every R&D effort would measure that item. It doesn't mean that that item will necessarily show up in a one-page summary.

DR. GOFORTH: There are two issues here. One's related to R&D studies and another is related to the need for a system like JWLLS or MCLLS for the Navy. I was told at one time that the Strategies and Tactics Group was developing a format to collect the kind of information that platoon leaders could record after each mission. That way NSW could have a data base on lessons learned. This may be an issue to address at another time. I realize that when a mission fails or has a problem, it's kind of a touchy issue. It's not always the sort of thing you want to record and publicize.

Getting back to the R&D viewpoint, should we make a note of any mission performance problems? Would you like to know if there are thermal protection system problems that occurred in a field study? Do you want us to report any mission-related problems in the data matrix?

Now, If you want to know why the problem occurred, that's another level of explanation that we need to insert and say something about.

UNKNOWN: As you were talking it made me think about some of our own field studies. The after-action reports said everything went fine. Observations in the field indicated that it wasn't so fine. I think the teams have to be a little tough skinned and candidly admit if something doesn't work. It's got to come to light. Researchers may have their own very favorite measure, but if it doesn't work in the field, it needs to be frankly reported.

I guess what I'm saying is that we all have to be a little tough skinned about our favorite projects not working.

DR. GOFORTH: Do you want us to note in our reports that there was an obvious performance-related problem during a study? For example, the crew hit the wrong end of a submarine, or they missed the target by a 100 yards?

CDR BUTLER: Do you expect to come up with a set of standards with all this input that will cover all the divers in the community? Or are you going to tailor it to specific mission needs? Different missions are going to have different requirements.

DR. GOFORTH: I would envision the product not to be a single matrix. I doubt there can be one form to cover all NSW missions. Somehow we should condense the matrix into usable sub-sets (e.g. long, cold-water dives).

CDR BUTLER: One of the things that you have to bear in mind is that this is our first stab at trying to standardize measures. It may be that somewhere down the road we'll want to separate SDV and SEAL missions. Take for example what Hal was saying. Do we want to know if they hit the wrong end of the ship? Yes. That should be in the body of the report. When Hal Goforth writes his report, he notes they hit the wrong end of the ship. For a standard set of measures, however, hitting the wrong end of the ship is not going to be a factor in laboratory studies. Many studies are going to be done in the lab. We need to be able to compare what's done in the field and what's done in the lab. If we do some sort of a simple reasoning test in the lab, we need to do the same sort of simple reasoning test in the field. Otherwise, we can't compare them. So we need the same test, or tests, to measure these performance factors. That is what will go on the one-page summary. Whatever other information is important goes in the body of the report. If you want more information, then you have to read the report

LCDR WOOD: You can put anything you want in a report, if it helps us understand what occurred; but when you're talking objective measures for the matrix, I think that information is irrelevant.

DR. GOFORTH: These objective measures are not necessarily for the matrix. These are objective measures that would be measured in every R&D-sponsored effort.

LCDR WOOD: Where is the focus of these objective measures?

CDR BUTLER: I share Mike's misconception. I thought we were talking about the matrix only today.

DR. DOUBT: I thought we were trying to develop standard measures. The translation question occurs tomorrow.

CDR BUTLER: The issue of trying to develop standard objective measures for all the different things that SEALs do is a 3-year task starting in FY93. Dr. Curley and company are going to be doing it. It needs to be done, but it's not going to be done in 2 days. At this workshop we're looking for a simple reproducible method of evaluating things like cognitive function, communication, strength, etc. It will be something simple that we can use as a comparison from lab to lab. You know, if we come up with three or four tests, every lab will do the same three or four tests. If we say manual dexterity is down 50%, Mike Wood knows what that is because he can go back and look at the proceedings of this workshop. Master Chief Jarvis can say I'd like my radio man to be able to communicate. If a study report says that his communication skills are down 75% in 30°F water for 3 hours in a wet suit, he can say I don't want my guy to be down 75%. I want him to wear a dry suit.

HM2 PAPPAMIHIEL: We need to be talking the same language so when you send us a report we look at this report and know how you arrived at this information. If we are considering using this equipment, we will know that you found it didn't work and we know how you got the information. What we're looking at is maybe having a little more interaction with you folks. Have training departments in the teams that we can help test equipment.

LT KASEL: We were talking about exposure. Let's say I know my radio man can turn on the radio and communicate. He goes out and operates for 6 hours. He can still turn on the radio, but his performance is down about 10%. Now, if he's been exposed for 14 hours in cold water he can barely communicate.

CDR BUTLER: The issue before us is which things do we want to measure to quantify his performance.

OSCM JARVIS: The first one that comes to mind is if a person's mind tends to wander when he's trying to follow a compass. It's not so much he's disoriented, but he just isn't concentrating. So they hit the wrong end of the ship. It's almost as if you're daydreaming, but you catch yourself doing it. It's not just simply a case of not paying attention. You have to work harder at paying attention under those circumstances than we would in this room.

UNKNOWN: You're talking now about the taxonomy of all of the missions, all the tasks. You have to identify the critical functions to perform each task, and then look at any measure that can be done in the lab and in the field. That's an issue that Dr. Curley is going to address later. We've got to find out what are all the tasks that your radio man does

critical to you being able to perform missions. Then we want some measure of his ability to do that. You may need another measure that can be used in the laboratory that somehow correlates to his ability to operate the radio. That's a really lengthy process that hasn't yet been done for all of your critical tasks.

LT KASEL: That's where I'm a little confused. I hear about the matrix for a little bit and then I hear about a report and then I'm hearing about gear. I know what I want to see on the matrix as an OIC. I could pretty much write them down for you. I'm sure you could work with our training department and get just about all the scenarios that would help in your research. That can be accomplished extremely easily.

CDR BUTLER: Now we're getting into performance. There's no way in a matrix you can cover all those functions that your radio man has to do. Maybe Dr. Curley could summarize the performance part right now or later.

CDR CURLEY: Later we will list them on the board, and ask you to identify those tasks, which in your experience, are where you see performance degradation occur.

CDR BUTLER: What we're talking about are direct measures that we can get off the body. We may want to know, for instance, "core" temperature. There are four ways to measure "core." We can insert catheters and get arterial blood; or we can get tympanic membrane temperature, esophageal temperature, or the dreaded rectal temperature. Which do you really want? We're almost in agreement that rectal temperature is what we really need. If I put that out as a proposal I'm going to get a lot of rejection from the SEALs.

UNKNOWN: We always argue about that point. But when researchers come out in the field they don't bring anything but the thermometer. We can forget the other three.

UNKNOWN: If you just say, we're going to do rectal temperatures, it's going to happen pretty much.

UNKNOWN: It's a military organization.

LCDR WOOD: There's no problem from the platoon standpoint of understanding the concept of a core temperature. You can understand core temperature dropping.

DR. GOFORTH: Alright. Under skin temperature, do you have a particular area of the body that you want to know the skin temperature. We think fingers and toes are very important. We could also talk about which finger and which toe, and on what part of that finger and toe.

LCDR WOOD: One of our criteria for pulling a guy out of the water was how white his feet were.

MR. DUDINSKY. How did you get to his feet to look at them?

CDR BUTLER: You guys are talking about people having problems with their hands and their feet. So, maybe you'd be interested in finger tip or foot temperatures.

LT KASEL: I'd say hands, feet, and face.

UNKNOWN: You can't hold a mouthpiece too well when your jaw gets numb.

DR. GOFORTH: Underwater we would violate the face mask seal in order to get a face temperature. A lot of people don't want seals violated because they fail often without any tampering. We've avoided, in most cases, trying to get a facial temperature.

MR. DUDINSKY: But you are going to violate the seal if you take a finger temperature.

DR. GOFORTH: Unless you're using dry gloves. When you use dry gloves, you can get finger temperatures. They have not allowed us to violate the wrist, if they're wearing wet gloves.

UNKNOWN: Did you try the feet at all?

UNKNOWN: Yes, we do the feet. We get toe temperatures on the fleshy part of the toe.

LT KASEL: How can you get the reading? Is this something wired to your body?

DR. GOFORTH: Yes. We put a box underneath the dry suit. Now, we're getting into the way we measure and that's not what anyone wanted to get into. It's what the measures are to be.

CDR BUTLER: Actually, we do have to get into how we measure it, but that's something SEALs don't need to hammer out. It's just important that we get hand and foot temperatures. As it turns out, we're probably only interested in hand and foot temperatures at the end of the operation. It's not important for us to know what the graph looked like during the operation. When the guy finishes the operation, is his hand temperature 12 or is it 18°C?

CDR CURLEY: Are we looking at fingers, or do we also want to look at arm temperature?

DR. GOFORTH: We were saying the extremity is the fingers and toes. Moving in, we're now talking about the limbs. Have we resolved the hand and the foot? We're required by the Human Protection Committee to stop our lab studies if a finger or toe

reaches a certain temperature.

CDR BUTLER: But, we're not required to put it in the matrix.

DR. GOFORTH: No. I'm just telling you we have medical requirements.

LT KASEL: Get the hands, the fingers, feet and toes, and the face. Personally, there's nothing worse than cold hands, but the rest of the body is a lot lower on my scale.

MR. WATTENBARGER: I'm confused. For the last 45 minutes we've asked everybody what measurements do you want. Most SEALS don't know what's important to measure. What it sounds like we're trying to do is to give the operator some kind of feedback after a study has been done.

We're starting out by trying to make a list of measurements, but nobody knows what use these are going to be. The first thing we need to do is decide how you are going to use the information. SEALS don't care how cold somebody's fingers and toes are. They eventually have to make a bottom-line decision; like, wet suit A is better than wet suit B. Certainly researchers have no problem with that because the first thing you do when you do a research study is write down your objectives. When the research study is written up, the researcher knows what he needs and he's going to say I need these measurements to make that evaluation. But what do the operators want? How are they going to use this information?

CDR BUTLER: First of all, we're not telling the researchers how to do the measurements. The researchers in the laboratory session tomorrow will probably argue all afternoon about how to do finger-tip temperatures, which finger, those kind of things. That's not germane for the team guys. But it's important for those guys to know, for example, that with the NMRI active heated glove the finger tip temperature is 20°C versus the 14°C we currently have with the gauntlet or Thundercloud glove. Those are things that they can understand. The finger tips were warmer with the active glove.

LCDR KEITH: What decision will they make based on that information?

CDR BUTLER: They would decide whether it's worth trying to incorporate the active glove—

LCDR KEITH: They don't care what the finger temperature is. They just care whether system A or B was adequate.

UNKNOWN: We care about our hands.

LCDR KEITH: First, they would have to know what the cut off is. May be 14°C is fine. How do they know that 14°C is too cold?

UNKNOWN: Can't you back up to say that they don't really care what the temperature of the hand is, it's what they can do.

CDR BUTLER: That's a good point.

DR. WEINBERG: What are the operators going to do with this information?

CDR BUTLER: Perhaps the more appropriate question for the operators is, on a scale of 1 to 10, how comfortable is your hand. Is manual dexterity 50% of what it was pre-dive. Is that what you're saying, as opposed to the finger-tip temperature?

LCDR WOOD: We've been concentrating on individual measures, but what we need to find out from the operators is, what decisions they're going to make with it. If they're going to get the report, the report's going to have everything in it.

CDR BUTLER: Most of them are not going to read the report.

UNKNOWN: That's right, so the idea is what do they want to see to make a decision. One decision is whether to buy wet suit A or B. Another decision might be should my team go out and buy Power Bars versus Milky Ways, and decide how many to eat. Once you point out what decisions they're going to make, then you gather information you need to make those decisions, not the other way around.

LCDR WOOD: I can tell you the information I'd like. I'd like this matrix, or whatever it is, to help me to decide whether I wear a C200 or C400, whether I wear this warming glove, whether I'm going to wear the new hard helmet, or whether I am going to wear a full face mask. That involves things like temperatures and percentage body fats and performances of different equipment items. That's what I'd like to get out of all this information. Help me decide what equipment I'm going to wear on an operation.

MR. WATTENBARGER: Suppose Dr. Goforth said wet suit A is better than wet suit B, as a conclusion to his test report. Would you take that at face value or what other information would you want? It may turn out from his standpoint that wet suit A was better than wet suit B, but it turns out that wet suit B may have been better for a particular mission.

CDR BUTLER: More importantly, you also have to compare it to wet suit C that they're testing at EDU and a wet suit that they're developing at NCSC. The idea is to be able to go back and compare all of these different studies and see what looks best.

LCDR WOOD: How do you trade off? As an operator trying to decide what I'm going to wear, I'd look at your study and try to figure out what mission did you conduct in that study, what was the water temperature, and was it an active or a passive individual. If you tell me that this wet suit's good on an active individual, it may not necessarily be good on a passive individual.

MS. WOOD: I think what you need is something fairly simplistic where "x" equipment was evaluated by so many people.

DR. GOFORTH: And activity level and body fat of the people so that you have some idea of what kind of body and what kind of activity level.

MS. WOOD: Well, that's what you need for the researcher. In research you do need to know all these temperature types, the measurement, all the various ages, etc. etc. A totally separate issue, I think, is that you have to be more subjective in decision making.

MR. WATTENBARGER: That was what he just said. If I had a choice to make, these are the things that I'm going to want to know before I make the choice.

CDR BUTLER: Just because you want it to be simple doesn't mean it can't be objective.

MR. WATTENBARGER: No, it could be objective. If I was trying to decide between A and B, these are the things I want to know. You would generally assume that wet suit A was better than wet suit B if thermal measures said it was. You can say, then, I don't care what the guy's skin temperature or arm pit temperature was. I know it keeps the guy warmer. But, there's a whole bunch of other things that I'm going to take into consideration besides that information.

LCDR KEITH: Don't you have to have some type of performance criteria to begin with? For instance, what do you want the guy to be able to do? With that you can then determine what measures you have to take to determine whether he can or can not do that.

DR. GOFORTH: That's why this whole workshop was proposed.

MR. WATTENBARGER: We've had one person get up here and begin to say that. This is how I would evaluate performance. This is how I would decide whether this is better than that. This is where the meeting of the minds has to come in. The researcher has certain measures to make his conclusion. The operator has to know how to use a given conclusion. There's a lot of intangible tradeoffs, and a lot of those relate to the mission. You have to be convinced that this thing was tested under conditions that are going to be appropriate to your operation. You know for some reason, even though researchers said it didn't work, it does work.

OSCM JARVIS: The thing that often comes to the operator's mind is, "Is the thing going to work if it gets nicked up?", like the dry suit. In a laboratory tank it would probably work better than a wet suit, but you take the wet suit because if you rip the dry suit on a rock, you're going to die as a result of hypothermia. That's not even related to the measurements we're talking about here.

UNKNOWN: But it fits in perfectly because earlier we talked about the conditions in which the thing was tested, whether in the field or in the laboratory. In the lab it may be perfect and by the time you transition to a field study, it starts tearing, so it doesn't work well there.

MR. WATTENBARGER: That's right. If you do a dry-suit evaluation, SDV may say this is great, but the SEALS are going to say dry suits are worthless because they haven't been tested in the way we use them. You would want to tell the researchers to test these things under the kinds of conditions that we use them. Can you even hope to design a dry suit that a SEAL is going to be able to use if the thing works? That's the kind of stuff that we really need to know, not necessarily what each individual measure was. Operators want to see information that's going to convince them that this thing is really going to be useful to them.

DR. GOFORTH: Along that line, I think it's incumbent upon us to include the SEAL operator when we design our studies. We should come to the operators before the study and say, what measure will convince you that this is better than another? You've been told "X" will work under these conditions and you take it out in the field and it doesn't come near to the standard that you read in the report. So, I think it's our job to bring you into the designing of this so that the results are reflecting your needs.

DR. GOFORTH: We'll take a core measurement. We'll take some skins and limbs, and fingers and toes. Heat flux is difficult to do under many circumstances.

MR. DUDINSKY: I don't know if anybody knows really how to treat the heat flux. It doesn't seem to have any real correlation to reality. Especially if you talk about active heating systems.

UNKNOWN: I think if you told an operator that a suit had 75 W/m^2, and another had 150 W/m^2, he would have no basis to know what they meant. If I know what the heat flux was under one set of conditions, I could tell the guy that one suit is more likely to keep you at a reasonable level for performance for twice as long as the other suit.

MR. DUDINSKY: Right, you could tell him what the predicted insulation was. I think that's a more realistic measure.

DR. GOFORTH: Well, if you had time and temperature, you've got the rate of change.

UNKNOWN: Does heat flux mean anything to you guys?

UNKNOWN: It means how fast the heat leaks.

DR GOFORTH: Alright, so time would be the other parameter.

MR. WATTENBARGER: Suppose you had two thermal suits. One was light and easy to put on and had a lot of mobility. The other one was bit of a cudgel, but kept you warmer. Depending on the mission length, you could then say, for short missions I want the lighter one, but for long missions it might not be very good. There you don't need heat flux or finger temperatures or the other stuff, you need an agreed upon measure of the thermal adequacy of this suit because that's really what the operator cares about. Now, you could use core temperature. But by the same token, the first thing the guy is going to do is go to a table that says when your core temperature is 37, here's what the performance level would be. That's a decision-making tool. After you decide the thermal end of it, you need to know the ergonomics of the thing, how well does it fit, how easy it is to put on. I've heard you would rather have a thermal garment that may not protect you as well, but if you can get it on and off in a hurry, you'd buy it. The SDV pilot doesn't care. Once he's strapped in, he can wear the best thermal protection garment and is not so much worried about the other aspects.

CDR BUTLER: Dr. Goforth has subjective comments listed. Maybe if we had two subjective comments: one, how hard is it to get on and off; and two, subjectively, how warm did it keep you. These would at least give you an index of ergonomics and thermal comfort. Would that be useful to you?

OSCM JARVIS: Would this be something you're directing towards guys who are participating in the test project, or just team guys?

CDR BUTLER: These will be just for the R&D studies. There's a place for feedback from the teams, but that'll be down the road.

DR. GOFORTH: So, will we pencil in these subjective measures. There are several ways to measure shivering. You can have a scale where somebody rates how much they shivered; intermittently, occasionally, moderately, violently. You can also measure an EMG to see how strong the shivering was and how long it lasted. Do you care how people shiver?

UNKNOWN: We're presenting shivering as an indirect measure. You said you'd like to have it as a measure of shivering.

UNKNOWN: Well, let's ask the Doctors.

LT KAUFMAN: It seems to me in order to get a good answer you have to know the question. I'm telling you what we want, but it's getting overlooked. I think if we try to define all the thermal objectives we're going to end up with a list as long as a Sear's catalog. I think we can boil a lot of this down to how well you can operate with what a platoon commander has available. For example, if I'm going to be in this water temperature for this length of time I look on your grid and see you recommended wearing these pieces of gear that we have in our inventory. That would be your best recommendation, and I think it

would give us the answers that we're looking for.

CDR BUTLER: Some laboratory is going to do exactly what you're saying, taking all these different thermal garments and comparing them. What we're looking at here is how to compare them.

LCDR KEITH: If I took a wet suit out on a mission and said, how did it work, what would you tell me? What things have you observed and recorded that would tell you how it worked?

LT. KAUFMAN: I would say, first and foremost, whether I had stayed warm; second of all, whether I was getting the dexterity required to do the mission. Beyond that, the comfort factor really isn't too great because more or less all wet suits are the same, at least in my book. Either A, they keep you warm, or B, they don't.

UNKNOWN: Or how long they keep you warm.

LCDR WOOD: Or, how long it keeps its durability. That's why these guys aren't wearing dry suits, because in their eyes they're not durable.

MR. WATTENBARGER: How do you decide whether you're warm or not?

LT KAUFMAN: I think that most of us that have been very cold, know when you become warm.

LCDR WOOD: Would a rectal temperature help you decide any better whether you were warm?

LCDR WOOD: Some of these scientists would want a rectal temperature.

LT KAUFMAN: I think I can tell you when I finished an operation whether I was comfortable enough to complete the job.

LCDR WOOD: If you got cold, and they told you your rectal temperature had only fallen 0.5°C and yet, subjectively, you were warm, you're going to say, "Wait a minute, I felt cold!"

LT KAUFMAN: Maybe scientifically that's not the best answer, but that would be the one I'd give you.

LCDR WOOD: But then, again, it really doesn't matter to you. What matters is the guy that's doing the swim.

CDR BUTLER: Let me use an example from the hospital. They ask somebody how

bad their pain is, one to ten. Some people will be rolling around in agony and they'll say three. You'll ask another person and they'll have a little headache and say 9.5. That answer is very, very, very subjective. Among team guys, some will be more stoic and less dramatic than others. A subjective thermal score is very, very important, but maybe we should break it into four general categories; too warm, warm, not warm enough, and awful.

DR. DOUBT: On a zero-to-eight scale, are you cold? Admittedly it's subjective. It says so in the title. When you see that, you know that it doesn't have the hard quantity of value that a core or skin temperature does.

DR. GOFORTH: But, what does it mean to be cold? Is it dysfunctional or just uncomfortable?

OSCM JARVIS: Well, in our area, too cold means you don't have the skills to complete your mission. If my hands are frozen and I can't pull the lever on the limpet, then that's too cold.

LCDR WOOD: That should show up both as too cold and a decrease in manual dexterity, right? So, you'll have both a subjective measure and an objective measure in that case.

OSCM JARVIS: Too cold can also mean that I've been staring at the optical sonar (OS) for 3 hours and I can't see dots on it anymore. We run into a pier because I couldn't concentrate on the OS. That's too cold. Now, if you're asking am I shivering, well of course I'm shivering.

MS. WOOD: The subjective comments also become very valuable in the sense that if you have one person and he's too cold that's one thing, but if 20 out of 20 people are too cold, that's another thing.

DR. GOFORTH: Subjective ratings will not really reflect the overall performance of a piece of equipment.

LT KASEL: Look at how consumer reports are done. You get a couple of things across the top and something along the bottom. We could have choices down there: my hands were frozen, my hands were warm, it was good on an SDV mission, it worked great in the field. We go down the side and color in our dots; we'd have a simple measurement.

LT HART: You're right. The point is what you put in those columns will be different for scientists. They could put temperatures, heat fluxes, etc. We'd understand that, but we've got to find out what to put on that measurement for you guys. You don't care what the heat flux is. Temperatures are really only a passing interest, so we need to develop a list of measures by which you would evaluate a piece of gear. Then, based on those subjective evaluations, decide how you would chose gear for specific missions. It's

that list that we need to work up.

DR. DOUBT: The follow-on session deals with the performance measures. As we discuss those, that will dictate, in part, what kinds of thermal measurements you need to make to establish the correlation. Remember I said at the beginning that this is mod-zero starting point. If there's a follow-on workshop, come back and look at these measures and their correlation. If you say, no, this really isn't working for us t n we delete that measure. Those two things are important to bear in mind. One, the performance session will give us some index of the tasks requirements to do the mission. That may focus better the thermal measurements that need to be done.

DR. GOFORTH: Nobody here has told me they care what the finger temperature is as long as you can do the job. So, we've kind of got the sessions reversed. We probably should have had the performance first. Then, given these performance measures, what thermal measures should be made to decide whether the performance level is met.

UNKNOWN: If I told you grip strength decreased by 20%, you don't really give a hoot about that. You want to know if you can pull the lever.

LT HART: Wrong kind of performance.

UNKNOWN: That's what I've seen, but it's just one of those kinds of laboratory measures that we could come out there and easily do and pass around and that really isn't the bottom line. We need to identify those critical tasks associated with your mission. I think that's going to be a major session. Once we've done that, then we can identify a measure of your ability to do that critical task.

UNKNOWN: Give me the clo value of a garment. I will decide whether that clo value meets my needs in order to conduct a mission. But I will also consider flexibility and durability.

LCDR KEITH: That's right, but that matrix doesn't mean anything to you until you've gone out and used the item. When you come back from a mission you decide whether, in fact, it worked.

HM2 PAPPAMIHIEL: I agree with that. There's going to be quite a few guys who are going to be interested in seeing data. But, and everybody in here that has been out in the field will agree with me, when it comes down to deciding what kind of gear you want, if Bill Winston or somebody has gone out and used the gear, subjective data are the deciding factor. If one of their teammates says, "Hey, I used this and it worked for me," they'll use it long before they look at data and decide whether they want to use it.

PERFORMANCE SESSION

CDR CURLEY: This is going to be a very focused session.

Please listen. This is the objective:

To develop standard valid measures of performance in the field or laboratory. Now, I'm going to tell you how we're going to get to that. Why is this important? We want to enhance the probability of your mission's success. How do we do that? We identify the critical areas of SEAL performance that are susceptible to thermal stress.

Two, once we've identified these areas, then we, in R&D, go back to our activities and come up with recommendations and solutions (or proposed solutions) to help you do your mission better. We evaluate them in a laboratory, take them out to the fleet, and use the standard measures to evaluate them in the fleet. If we don't have standard measures, we can't do the evaluation. So, we identify the critical areas of performance, come up with recommendations, and evaluate the effectiveness of the recommendations.

Are there any questions on that?

We all know that mission performance is usually not "all or none" because it costs. It costs in mission resources, how many men are incapacitated, how much money you use, how much equipment is lost. We know that how fast you do the mission is a function of thermal stress. We know that how accurate the mission is accomplished, and whether all of the objectives are accomplished, is a function of thermal stress. So, while we talk "all or none," part of the R&D effort is to help you do it all without a significant cost in resources.

These are the assumptions and these are the givens: that all the folks and all the operators are super performers; that they will put themselves at risk to accomplish the mission, even to the jeopardy of their physical well being and giving their lives. We understand that. We understand that they have great motivation, but we also understand that they are human beings and as human beings, they are fallible, and make mistakes. We make mistakes due to stressors, and today we're talking about thermal stress.

So, some equipment fails because of improper operator PMS, and because of operator improper operation. And, we all realize this even though we don't like to talk about it. But, we're going to talk about that this afternoon. That's what we're here for. We're going to ask you to help us identify those areas, those critical task areas, of performance that are essential to the mission failing or succeeding.

Now, radiomen may have 50 critical tasks, but in your experience what particular performance degradations occur that are critical to the mission's success?

Is this clear? If it's not clear, I need to go over it with different words, because

that's what this session is about.

This morning we heard from Master Chief Jarvis. He talked about "daydreaming," "hypothermia," "people don't pay attention on a compass swim." It's in the literature; it's reaffirmed by what he said; it's reaffirmed by what the petty officer said: "Loss of Concentration." These are the concerns that we need to identify this afternoon.

Dr. Thomas is a researcher who has worked with cold-weather performance. We've been talking about extremes, extremes of cold and extremes of heat, but we also know that performance can be degraded between the extremes. It may only take the difference of a degree or two in a wet environment to make a significant difference in performance. So, we're going to ask you some specific questions, and we're going to write down your answers. I really do hope that you'll participate, because this is what it's all about. It's really about enhancing mission success.

DR. THOMAS: I would just like to emphasize what Mike just said, that we tend to think most often of extreme thermal stress and the problems that it may cause. That is not always the case. There are many incidents reported of people getting themselves in problems when it's been non-hypothermic. Change on the order of maybe only 2/10ths of a degree in the brain is very significant in terms of messing up CNS functions. You don't have to always observe some 2°C change in core temperature to be in a problem situation. At all times it is a keen, well-trained eye that is able to pick up in himself or is able to pick up in his team mate some very subtle symptom or change or some deviation in the mission protocol that shows one of his teammates is no longer following that procedure.

These are the kinds of things that we might want to think about in addition to somebody just sitting there and shaking to death, or that their hand doesn't work. It may be that the inability to remember what you were doing just a second ago is impaired, now you're okay, but you realize for that one second, you're not sure what you were doing a minute ago. That is, a warning flag goes up. And that's something that some people listen to.

Thermal stress produces performance problems. There's no question about that, and some of them are subtle, and some of them are cumulative over time. The longer your mission is, the higher the probability that something is going to pop up.

We have things that we measure in the lab. We have things that we can tell you about, just as on the thermal side there are things about cognitive function, mental function, performance aspects. We know, for example, that very, very subtle non-hypothermic brief exposures to cold can induce short-term memory bad enough to produce problems. We have seen that in the lab. We have seen that reported in the field. There's no question that thermal stress can produce performance problems.

It would help us help you become more efficient in the performance of your missions

if we could get a feeling of the type of mental characteristics, the mental performances, the mental behaviors that you think are the most critical for performing your mission. Let's just say it this way: what are the five most critical mental behaviors that you can think of that are important for the accomplishment of a mission? We've heard this morning people talking about loss of attention. We've heard people talk about communication, and memory. It was in several of the handouts that people presented. Navigational skills. One could generate a list that goes on and on. CDR Curley had a list up earlier this morning, you know, of dozens.

But what are the five most critical?

CDR POLLAND: Well, another one that you alluded to is hand-eye coordination. If a guy can't drive a boat, or put the lever up to shoot the gun, or drive an SDV, that's critical.

LT KAUFMAN: Navigational skills.

DR. THOMAS: Okay. What about navigational skills?

LT KAUFMAN: For me, it's more a sense of knowing where I'm going. There's no way to define this scientifically.

DR. THOMAS: Okay, is timing part of that?

LT KAUFMAN: No, for me it's basically internal gyro. Some people have it, some people don't.

LCDR WOOD: Is it vigilance, staying on the task?

LT KAUFMAN: I think to a large degree, yes, sir.

DR. THOMAS: Does somebody else have any other terminology that relates to that orientation?

LCDR WOOD: Well, I think different forms of perception: depth perception, determining relationships between objects, and as far as navigation, you've got short-term memory. You need to know what courses you're going to be on, you need to know the relationship of what course you're on now, and what impact it will have on your next course.

LCDR WOOD: Long-term memory for keeping the long-term picture of your navigational process. In other words, if I'm doing this course, this course, and the next course, what's the impact if I'm off course now?

CDR CURLEY: General reasoning ability.

UNKNOWN: Analyzing or projecting impact of actions taken now, and how to correct for any errors that occur now. .

LCDR WOOD: This ability goes fairly quick when you get cold. You start losing the relationship between the course that you're on now with what happens to this course over here, if you've reset on the wrong point.

DR. GOFORTH: It's a conceptualization problem, being in a black box and thinking you're some place and not knowing where you really are.

LCDR WOOD: But, even if you make a mistake, what's the impact?

CDR POLLARD: That can be summarized in three things: analysis, prioritization, and synthesis.

CDR CURLEY: We've identified two critical tasks. First eye-hand coordination, whether it be for driving SDVs, for aiming a rifle, or rigging an SDV for a launch. Eye-hand coordination seems to cut across many of the different tasks. Second, navigational, which includes visualization, memory, reasoning, centralization, and prioritization, synthesis, and analysis.

DR. THOMAS: From listening to several of these, I think I would put memory not as a subdivision of navigation, but as a major skill in itself.

CDR BUTLER: Memory or recall?

DR. THOMAS: Memory, or recall. We're talking about a specific type of memory. We're not talking about your name or what your Mother's house looks like. It's something that's going on right now. You've got to juggle what you were doing just a few minutes ago, a short-term or working memory concept.

LT KASEL: You might know where you're at, but now that I'm here, I am confused about what am I going to do next.

DR. THOMAS: I think you're right, Mike.

CDR CURLEY: What if it's the platoon leader? He says "What am I going to do with the squad now?" "What are my options?" "What's my availability?" You must make a decision where you don't have a go, no go; rather you've got that gray area in between.

DR. THOMAS: What aspects relate to communication between team members? Communication has come up several times, but has not been precisely specified.

LT KASEL: Well, communications from the radio standpoint are important.

DR. DOUBT: Is intelligibility of speech important?

HM2 PAPPAMIHIEL: Yes. Being able to communicate the appropriate response. You know, you might be thinking one thing, but something else is coming out.

CDR BUTLER: Have you ever been in a situation where somebody came out from a very cold exposure and you asked them questions? And they're sitting there going, "ahhhhhhh"? They either can't talk, or you can't understand what they're saying, and they just drool?

LCDR WOOD: Well, communication is pretty broad. Communication is verbal, communication is done through tap signals, communication is done through hand and arm signals, communication is typing on a keyboard.

LCDR WOOD: There are several areas of communication utilized in SEAL and SDV operations.

CDR CURLEY: In your experience as operators, when there has been a failure in communication, what form did it take? Or wasn't there a problem in communication? Other than equipment, we're talking about personnel behaviors.

LT KASEL: Somebody maybe made a wrong call. I'm thinking of an instance where the OIC was under the weather and he actually made a wrong call. By the time we realized it, everybody was moving at about 1/10 speed. We sat there and I explained to him what we were doing, and he was almost incoherent. He was talking about last week. I took him out, put him with the APO, took over and we went on for the next 3 hours.

LT KAUFMAN: Yes, but was that a communication problem or a logical reasoning problem?

CDR CURLEY: Now, that sounds like it was a problem with logical reasoning, which may signal that many of our communication problems are a failure of logical reasoning due to thermal stress.

DR. THOMAS: Or failure to remember what you were talking about just moments before.

LT KAUFMAN: I've seen very few actual communication problems among the squad members. Problems do develop. I guess the only thing I could comment on is a lot of times people are preoccupied with the fact that they're cold, and don't necessarily pay attention to the word that's being passed. That would be the biggest communications failure I've noticed.

DR. THOMAS: But that's again getting back to the lack of attention.

HM2 PAPPAMIHIEL: It's coming out of communications as a symptom of loss of logical reasoning.

DR. THOMAS: I like that, which says that the term communication is probably too global a term.

UNKNOWN: And, did you have concentration up on that list?

UNKNOWN: And, attention span ought to be in there somewhere.

CDR CURLEY: Is attention a critical task?

UNKNOWN: Absolutely.

UNKNOWN: When you lose it.

DR. THOMAS: Yes. That came up several times this morning, a lack of attention or drifting.

LCDR WOOD: Attention/alertness, I don't know what you want to call it.

UNKNOWN: Or concentration.

LCDR WOOD: Concentration—

UNKNOWN: Mind wanders.

LCDR WOOD: Because if you lost your concentration and you're looking at the compass board, you're going to lose your positional relationships as well as your ability to navigate.

CDR CURLEY: Do these five cover all the critical areas that you've seen?

UNKNOWN: Depth perception join in all that?

CDR CURLEY: Yes, depth perception is more of a physical, psychological, visual combination.

OSCM JARVIS: Those are all mental traits. There are also the instances in the snow where a guy's hands go bad, and he stumbles around a lot because his feet are too cold.

CDR CURLEY: These are all mental tasks: memory recall is mental, logical reasoning is mental, attention/concentration is mental. Eye-hand coordination is psychomotor, as it has a motor component to it.

Are there any other mental or cognitive areas that are "show stoppers?"

LT HART: Let me ask your judgment on one that I have and then if you think it is a mental component we can list it. I'll ask Mike Wood to comment on it. I'm referring to motivation or confidence. It seems to me that the guys that come out of the water because they're too cold, they've lost their motivation, they've lost their confidence, and the ability to perform their task. The guys that come out with a successful mission are still confident, and are still highly motivated. I'm not sure where the cause and where the effect is, but the cold has taken away their motivation and their confidence, and therefore, the mission has failed. Or perhaps the mission fails and that takes away their confidence. But, it seems to me that the cold really sucks the motivation and the confidence.

LCDR WOOD: I think it affects your motivation, but I think more than that it affects your responses regardless of how you're motivated.

HM2 PAPPAMIHIEL: I think the question of motivation comes into play more before the operation ever occurs. That has to do with the training that the guys get before they go out, and how well they're prepared to go out and do the operation itself.

LT HART: Mike, I'm thinking of a Bangor, WA, where you've got a successful mission. The guys have come back, still motivated, and have a lot of confidence by somebody that's been out on a 6-hour mission. Contrast this with when they come back after 3 or 4 hours because the boat's failed, or a Mark 15 has failed, or whatever reason, but those guys are really burned out. They're tired, they're exhausted, they're unmotivated, and lacking confidence. Is that because of the cold or exhaustion?

UNKNOWN: There's impact on thermal stress.

LT HART: So, if motivation belongs up here in a mental behavior, is it a critical factor for mission success? Is motivation a critical factor for mission success?

CDR POLLAND: It's been my experience with operators in the SDV arena that being in some real cold situations, inappropriate affect occurs. You can take a guy who's a very good operator, who becomes hypothermic, and you'll find him hanging on the end of the hanger grinning like a raccoon with a bunch of eggs in his hand. He's beyond shivering. You may try to communicate with him and he just grins at you. That's inappropriate affect. When you get him back in, warmed up, he says "I don't remember that." I can think of one case or a number of cases. So, you're looking for a sign, "What does a guy do to manifest this?" It may be subtle, it may be more evident, but it's something that you need to look at and you need to key on. As the problem progresses, it may become more frank, going from more subtle.

DR. THOMAS: What are other symptoms that one would use like that to tell you that your team mate is in trouble?

CDR POLLAND: If you're talking about an SDV in the hanger, where you're submerged in very cold water, you may not have the opportunity to converse with him. Whereas, if you're in the north somewhere, up in Canada, and you're doing the inter-operations up there, you're able to talk to the guy. It depends on your capability, if you will, to communicate with that individual at the time to establish the depth or the extent of what the problem is and to take the appropriate action. Does that answer your question?

DR. THOMAS: Yes.

LCDR WOOD: To determine the guy's alertness without verbal communication is to observe whether he's doing the next task.

DR. THOMAS: The next part of the new scenario.

LCDR WOOD: Right. And, also his responsiveness. If there is an incident, how long does it take for him to respond with the correct action in a particular skill? So, alertness and responsiveness to tasks help determine his—well, what other one was up there?

CDR CURLEY: You're talking about his reaction time.

LCDR WOOD: Right.

CDR CURLEY: To the specific situations.

CDR POLLAND: To communicate on the SDVs they developed hand signals that you had to respond to. You make this signal, and they had to respond this way back rather than going. Because you couldn't talk, they had to respond. That way we were able to identify those people that were suspect for the beginnings of that type of a problem.

DR. THOMAS: Are the hand signals developed purposely, specifically to that end?

CDR POLLARD: Yes.

DR. THOMAS: To see, "Are you still there?"

CDR POLLAND: Well, they had hand signals for accomplishing different things anyway, but if they suspected that there was something wrong, then they could go over and utilize that.

DR. THOMAS: Use that as a test probe?

CDR POLLAND: Yes, and that was kind of a test, if you will.

DR. THOMAS: Is that common to do that?

LT KASEL: Yes, on basic one-inch visibility dives out in San Diego Bay, generally one squeeze is "I'm okay," two squeezes, "no, I want to stop," three squeezes, "slow down." Every dive buddy I go through, we say let's make sure we have the signals straight, and every 3 minutes I'm going to give you a squeeze, one squeeze to know that you're okay, or if I stick my arm out like this, tell me how you're doing.

LCDR WOOD: And if he's slow in responding to that signal, it begins to be an indicator of his condition.

DR. GOFORTH: I was going to second what Mike said, endorse it a lot, because in the SDV trainer, when people get cold, we see they fail to volunteer information to their partner. Their responsiveness is really degraded or decreased. They close in; events will occur and they don't respond to them, and they delay the passing of that information on to their partner. Sometimes, to the detriment of the mission, they see something on the screen and just do not respond. The same thing occurs with the hand signals, by the way. That's developed because equipment fails. The reason they developed the hand signals was because their verbal communications systems would break down. They do use it to say, "Hey, how are you?", and if the guy isn't very responsive again, I think that's the key to his having problems.

DR. THOMAS: Do you have the delay time or response time?

CDR CURLEY: Well, I think this is one of the things I want to clarify. We are not talking about attention or concentration, as they seem to be attending. As far as we can tell, they are concentrating, but their reaction time or responsiveness is impaired. So that would be a separate category.

LT KASEL: It appears that they're paying attention, but they don't pass the information, they don't respond appropriately, and they don't respond rapidly enough. Would you agree with that?

UNKNOWN: Yes.

LT KASEL: I'd say it's kind of like a drunk. If a guy has four beers in him, he's kind of like, "Ohhh, okay, here's what he's wanting me to do." That's the way I can think about it.

CDR CURLEY: I think we've obtained what you've verbalized, most of the critical, mental and cognitive aspects are covered. Last chance to add topics. Navigational, memory recall, logical reasoning, attention and concentration, and responsiveness. We've also talked about motivation and affect, which are partly mental behaviors.

Let's move on to psychomotor. Now, the Lieutenant, in the physiological sessions, said these are the things that I want to know that my operator can do. And most of them

were physical measures. Could you repeat what they were? Do you want to know if they can set up the rig?

UNKNOWN: It's on that list I just handed you.

LT KASEL: Just a couple of quick ones. Can he pull his trigger and handle his weapon? Turn and fire, pull his trigger, change magazines? Something snipers do on a hot day.

CDR CURLEY: Okay, eye-hand coordination. What about strength? How much strength is involved in these operations? Let me focus this. What critical elements of your mission require strength that would be impaired by thermal stress?

UNKNOWN: Climbing a ladder out of the water.

CDR CURLEY: What's involved in climbing?

UNKNOWN: Arm strength, grip strength.

LCDR WOOD: I've got several strength ones if you want them all. For the DDS, just opening up a hatch, pushing it against water and creating air pressure. Pulling an SDV against current and surge, and pulling it down onto the cradle are other examples.

LT KASEL: If I might interject, if he doesn't do it right, it will crush his hand and he's got to be careful. He's got to get it done without crushing his little finger and cutting it off, so it takes appropriate strength and quickness.

LCDR WOOD: For the combat swimmers and SDV, they need to be able to swim, have leg strength for swimming, and the SDVer needs arm strength for opening and shutting the SDV hatch under waves.

UNKNOWN: Pulling one through the surge.

LT KASEL: Pulling the whole boat off the beach, and getting it through the surf zone.

CDR CURLEY: Let's back up. You need strength to pull it off, you need balance, coordination—

LCDR WOOD: Not only do you need balance on dry land, but you need balance in a weightless situation.

CDR CURLEY: Let's make sure again that we're looking at critical areas that you've observed some performance decrements in, or are likely candidates, in your estimation. Certainly the things that you're saying are appropriate.

LT HART: Critical tasks could be for the hands, upper extremities.

UNKNOWN: You're talking finger dexterity?

LT HART: But you also need that for upper arms, head control, motions—

LT KASEL: Cross country skiing—

LT HART: Coordination, especially if you've got an eight-pound pack on your back.

UNKNOWN: So, that's both limb and full body.

CDR CURLEY: Okay. Eye-hand coordination, psychomotor behavior, climbing, arm and grip strength that involves some hand-to-eye coordination. It also would come in here and fall under physical tasks: opening a hatch against resistance, pulling the SDV through the surf (that's also a physical task), balancing, and balancing weightless, fine motor control, finger dexterity (and it's certainly a psychomotor task), coordination (limb and whole body), and this is for paddling. Right.

Does everybody know what a psychomotor behavior is? Psychomotor behavior occurs when you're performing a voluntary action in response to some stimulation. You see something and you reach for it, like eye-hand coordination. It does not necessarily involve strength. When tracking on the SDV, you're using your body to respond to different inputs.

LT HART: Perhaps reaction time may fit in a little bit better, to distinguish between the tentative portion and the reactive portion.

CDR CURLEY: Right. Simple reaction time involves almost a reflex response to a stimulus. For instance, if you're presented with a traffic light, you've got one response to make. To a red light, you slam on the brakes. It's a typical, simple reaction time task. From the time you see that stimulus until the time you take an action is reaction time. We talked about complex reaction time, where not only do you have to respond to the onset of one or more lights, but you have one or more decisions to make. That starts involving the reasoning component, which is more of a mental process because you have to employ some decision making. You have to weigh and discriminate among stimuli and choose an appropriate response. So, the complex reaction time may be degraded if he was impaired, because there is a cognitive component to it. Simple reaction time, we place under the psychomotor category.

LT HART: We're talking about thermal injuries, starting i.v.'s and doing medical procedures. I mean you've got your patient in that situation and you're also in that situation.

CDR WOOD: I have a question. Is determining the amount of strength for pulling an SDV on its cradle a psychomotor behavior?

CDR CURLEY: No, that's a task-analysis statement. What we're doing, remember, is identifying the critical areas, critical tasks first. Once we've done this, then we will go back and break it down further. With your help the investigators and the scientists will meet at a later date, and outline what particular components it takes to do an i.v. I mean exactly what abilities are used, step by step; e.g., you look at the man's arm. You visually sight where you're going to place it. You use your wrist to turn over the man's arm. How are you going to hold the needle? What muscles are used in that action? How much strength does it take to puncture the skin? At what angle does the needle have to go in? That's a finer task component analysis than we're going to get into here. We've got a broad task analysis; a critical task list. We can look at that, and measure it in the laboratory under different conditions of thermal stress: in the normal, moderately cold, very cold, and hot environments. We will then come up with procedures to help you do that procedure or that operation better under conditions of thermal stress. Then we will go ahead and evaluate it in the field.

CDR CURLEY: Anything else under psychomotor?

LT HART: Why, in the SDV trainer, doing your cold water study, didn't you see a lot more errors by the pilot controlling the control stick when he was cold?

DR. GOFORTH: Errors occurred when they were resetting in the wrong place, and weren't responding to detected targets appropriately and communicating to each other. It really wasn't just holding a stick straight. We didn't see that as a major failure in the individual.

UNKNOWN: Well, one of the things is they'll lose depth control. Being on course with a compass is easier to maintain than depth control. And an SDV pilot uses a tremendous amount of psychomotor skills. There are several gauges that he's looking at which are going to determine what actions he takes on the stick. It's three-dimensional.

CDR CURLEY: So, more than an eye-hand coordination, it's a tracking task. And, it's also an information processing task.

UNKNOWN: A three-dimensional tracking task. So, it involves more than just sight. The question is how much of that is also equilibrium.

How much is your balance involved in this? Are you using it, or are you simply following the information presented to you and just tracking it?

LCDR WOOD: If you're feeling pressure on your ears, you know you're diving before you've even looked at the depth gauge. And, also, if he's having an inner ear problem, it'll affect his ability to maintain depth.

UNKNOWN: You're using your sensations to balance.

LCDR WOOD: Well, you're using it as a small part of it, but the interim is really our priority.

CDR CURLEY: Anything else on psychomotor behaviors? No? What physical tasks do they have to do that, in your estimation, are likely to result in a casualty? Or require you to take more people along with you?

LCDR KEITH: The transition between water and land is very important. This occurs where you're moving into a walking position, the transition from fin swimming or just sitting in an SDV to having to walk or run.

UNKNOWN: What does that do to you?

LT KEITH: Well, it's just a lack of coordination, usually involving the cold, leg muscles, joints.

UNKNOWN: How about mobility and dexterity, particularly the hand?

CDR CURLEY: Okay, mobility and dexterity. We know about land mines. Where else has it been or is it likely to be a mission stopper?

UNKNOWN: PMS a technical vehicle.

CDR CURLEY: Does anybody know how much pressure it takes to activate your bypass in cold water? Have we done those human factors?

UNKNOWN: You mean if you can reach it?

CAPT THALMANN: It depends on how much pressure is on it. Has anybody ever not been able to activate their bypass when they had to? I mean, it may be a pain to do it, but has anyone ever been unable to feel or push it?

LCDR WOOD: Are you talking about the Mark 15?

CAPT THALMANN: Yes. I know that it's a matter of—

LCDR WOOD: Dexterity and strength. Even if you can find it, you can't push it.

UNKNOWN: Well, can you do that when you're warm?

UNKNOWN: Oh, yes!

CDR CURLEY: Do you think it's more a problem of being able to find it or pushing it? What do you think is the biggest problem?

UNKNOWN: Reaching around all that rubber is a problem in itself.

LCDR WOOD: If you wear enough rubber on your fingers to actually be able to push it—

HM2 PAPPAMIHIEL: You won't be able to feel it.

LCDR WOOD: You won't be able to feel it through all the rubber.

CAPT THALMANN: So, some of that is directly equipment related, and involves manual dexterity.

CDR CURLEY: What other aspects?

DR. DOUBT: What about endurance, the ability to continue a prolonged task?

DR. GOFORTH: I was going to mention that. They said paddling and swimming, but it wasn't just pure strength, it's endurance. I didn't want to bring it up. That was kind of splitting hairs for them, but when you mention a task and the muscles have to act over and over and over, that becomes endurance, not just strength. If it's one major movement on top of the value or pushing a hatch open, that's strength and power.

CDR BUTLER: Well, let's think beyond just a few tasks we've talked about here. Where do strength, power, and endurance muscle performance come into play?

CDR CURLEY: You know, in your experience, that there are certain tasks that you do where people tend to have more problems performing under thermal stress. I would guess that in most of the tasks you do, people can overcome the stresses and they're not show stoppers. Most task failures haven't aborted the mission, or resulted in mission degradation, but there are some, and those are the ones that we, as the researchers, need to identify first. Why? Because that will give us the highest probability of success in helping you solve that particular problem. We need to focus on those issues which are going to give us the greatest pay off.

LT KASEL: Ship boarding. Yes, the ship climbing ladder comes to mind.

CDR CURLEY: Is that basically grip and arm strength?

UNKNOWN: Arms, leg, the whole body.

UNKNOWN: A lot of coordination is required climbing up those ladders because they're not stable.

HM2 PAPPAMIHIEL: As an example, I don't know if you guys have seen the

ladder that we have to climb, but the rungs are about 7-8 inches long and it's on a wire cable. So, the ladder is just big enough to where you can get a boot on it, and grip it with your hand.

OSCM JARVIS: It's like a real small Jacob's ladder.

LT KAUFMAN: One other thing that's not listed, but I think we can cover it, is the electronic equipment. It includes anything from a radio to a laser target designator and associated gear. One of the things you mentioned, more specifically, is that it seems you need it all because there's not one thing that's a show stopper, and I guess I'm not sure what you're really asking because we could start from the very beginning and list everything—

CDR CURLEY: What you've given us, out of the range of thousands of different tasks that you do, are tasks that involve these abilities. You've also given us examples of where those tasks fall, and which are the most likely candidates for us to develop standard measures that will give us the highest pay off. That's why we have limited it to five or six. There are hundreds and hundreds of different abilities and psychomotor skills. Our job now is to take this grouping and start taking it apart, dissecting it, and getting to the heart of it. The researchers will analyze those measures which are going to give us the most payoff, and are valid, reliable, and appropriate. You've given us what we asked for.

DR. THOMAS: We are identifying measures that are capable of becoming standardized for use in the lab and portable to the field.

CDR CURLEY: That's right. For all of these tasks that you've talked about, there are standard measures that exist. So, we don't have to develop new measures. What we have to do now is go back among the laboratories and choose simple, effective measures that are out there already.

CDR POLLAND: Under responsiveness, you might put discriminatory under there as a sub-title. One member who died had on his MK-16. His O_2 had run out and his failure light had gone on. He failed to respond to that appropriately, he failed to discriminate, and that was part of the scenario.

CAPT THALMANN: You also have to remember the flip side of this. From the operator's standpoint, how does he know if someone is reasoning logically? We've heard a great deal about logical reasoning, but the point is, how can you tell whether somebody is reasoning logically? How do you know if the hand-eye coordination is okay? There's 30,000 ways to test it, but if you are on an SDV operation, how do you know? It could be there are certain specific tasks that you do, that you say, well, I know if I can't do this, then my hand-eye coordination has gone. There's one or two things that stick in your mind that tell you whether that task is being performed correctly. Sounds like within logical reasoning there are some very recurring navigation problems that you kept tripping up on. And not only that, but it sounded like the navigator almost would know when he was tripping up on

it. But, those are the other kind of things that you need to focus on because there may be a lot of standard measures, but we would like to be able to have the operators communicate to us, whether these things have improved or not. At the end, it's a matter of determining whether any of this stuff is improving performance. We can say it worked in the lab, but how do we know in the field if it's working?

CDR CURLEY: Right. That's part of the process that's going to have to take place. You and I need to convey to the people that we represent, that this is a first step, and this is going to be a continuing process. We're going to go back to the operators and delineate what we think is reasonable, and try it out in the field. Before we try it out we're going to come back to you and say, "Does this make sense to you? This is the reason why we're doing this." This is our rationale for these particular measures. This is the simple measure we think you can do and then we have to validate these measures against real world performance to make sure that what we are measuring reflects what your input has given us today. That's the only way we're going to be able to do that. We must implement some of these measures and observe them in the field.

Any other comments? Thank you very much for being focused. This helps us a great deal. I think Dr. Doubt has some closing remarks.

DR. DOUBT: Yes, just a few. Recognize it or not, I think we've accomplished a lot today with our dialogue. At times it may have seemed unfocused, it may have seemed overwhelming in terms of what we tried to do, but as we've said, this is a first step. And, we now have some very useful information that can be digested, and can be put into standard measures in our sessions tomorrow. Once something goes out to the teams and they say "It doesn't work," "We don't understand this," we come back and we modify it. And, if you think about it in the long range, what we do is develop a useful solution. I think we've accomplished a lot today.

Our sessions tomorrow will look at some of the things we've already talked about today in terms of what kind of reporting format is useful, whether we need follow-on sessions, or how we go about correlating the performance measures with the magnitude of the thermal stress. In the afternoon session, we will discuss how to make measures in the laboratory and in the field.

CAPT THALMANN: Since I've got tomorrow morning's session, get ready for your homework assignment. The homework assignment is if you get this information, what are you going to do with it, what good is it to you? For instance, are you going to use it to measure things, or are you going to choose equipment, or both? Second, what kind of decisions are you going to make with that information? The format will depend on that answer. So, think about it.

DATA FORMAT SESSION

CAPT THALMANN: This is going to be an interesting session because I'm going to be pointing out what we're doing. I hope everybody has figured out what they would do with data. We have to make some assumptions. First, is there some kind of agreed upon format for agreed upon measures.

As an example, let's say that we're going to go out and see what's the best kind of wet suit we can find. NHRC takes these out on some operation and evaluates, say, three different kinds of wet suits. They now have all these data sitting around and they're going to eventually write a report which will be three volumes of scientific words.

From the operator's standpoint, what information do they want out of that report? Realize of course, that a lot of the information may be preliminary. This information is probably going to be incredibly useful to NHRC and to other R&D labs. Based on that information, decisions will be made on future studies. In that report may be some information that's immediately useful. For instance, I've got an operation next month and I want to know, based on data that exist right now, which one of these wet suits should I buy?

For starters, we'll talk about how data generally flow. This is one way that might be useful. We have three players: WARCOM in the middle, the individual teams, and the R&D labs. There are two data cycles up here. One is an R&D cycle that interfaces them with the teams, and maybe a little with WARCOM. These studies are generally done in conjunction with the teams and WARCOM. WARCOM acts as kind of a broker in the middle, to get up enthusiasm, to provide bodies, to allow the investigators to meddle in their well-oiled machines. The other cycle is the feedback loop that right now evidently does not exist. In the feedback loop are the teams with Theater Operational reports that keep NSW updated on problems, how equipment performs, etc. So, we have a way of getting problems to the team level, briefing the command, a central coordinating agency, and a means to get these problems to the R&D labs.

The R&D labs could enter a research cycle, if the solution wasn't immediately obvious. Or if the solution was buried in those reports, they could pull it out and get the solution back to WARCOM, who then passes it on to the teams. Who would turn the solution into a product is one of the things we need to discuss. Generally this transformation is not necessarily straightforward. For instance, a solution to a thermal problem may be a thermal model. But 16 pages of differential equations aren't going to do the operator any good unless he's got a way to actually use them.

Now, how would that model be distributed?

The best I could come up with is basically three ways. We could incorporate reports into some kind of handbook. The closest analogy for diving would be the Diving Manual. That's a way that information is distributed on a periodic basis for diving. Another way is

messages that go out real fast and tell you, "Don't swim with this regulator because you'll die." That's for a fast response.

What I think Dr. Butler is looking for is something which is a concise, distilled picture of an R&D study that pulls out all the essential features of interest and is immediately useful to the operator. We can either say data or decisions. What decisions are you going to make with the data?

You can use the data to measure how equipment performs, how people will perform, or how procedures will perform. This is part of that feedback. By the end of an operation, operators would have some sane measure of how things worked during the operation. Along with that, they would have some sane way of recording it.

The other thing data are used for is to choose stuff. Before an operation, what equipment should you use? What particular procedures are you going to use? What kind of plan are you going to have? We've got to start here with what decisions will be made using this information.

Let's start and see what kind of decisions you need to make using this information. What kind of things are you going to use the information for?

LT KASEL: First thing I'd do, is recognize limitations. Like temperature limits. If we get data that are for 54°F and below, you need to know that. Start making decisions for the right garment for the right operation.

CAPT THALMANN: So, you've got two things. You want to determine the limits, but you also want to determine the equipment. These are going to play back and forth.

LT KASEL: Something else that I think would indirectly come out of this study is to learn how to recognize, a little better, symptoms of cold water injuries.

CAPT THALMANN: We call that evaluating reports. These limits would hopefully allow you to avoid injury.

LT KAUFMAN: I think we'd be able to provide our supply departments with more accurate data, as far as what should be purchased.

DR. DOUBT: Do they ever use this information to make personnel selections on who goes on an operation?

LT KASEL: There shouldn't be anybody in the platoons who wouldn't be able to perform everything on an operation.

CAPT THALMANN: Did you ever use this information to decide how many should

go on an operation?

UNKNOWN: That would be based on the mission itself, not the equipment you had to use.

CAPT THALMANN: Suppose that the operation requires you to push equipment to its limit. This information could then be used to determine whether you should take 10 guys instead of 5, because you're not sure if everybody is going to make it. Some of the guys may become so hypothermic they can't complete the mission, they will be unable to perform.

HM2 PAPPAMIHIEL: They can use it to determine performance levels of the equipment itself. If you're wearing a wet suit and it keeps you warm, will it also allow you to climb a shipboarding ladder? We need enough range of motion with the upper body to climb a ladder.

CAPT THALMANN: So, you would evaluate both the people and the performance of your equipment.

LCDR KEITH: Duration? Given the temperature and the equipment duration is equal.

CAPT THALMANN: The limits would be temperature and duration.

CDR POLLAND: From my experience, at least, these guys will do a lot of things, but they're not going to participate in something which is going to put them at extreme risk.

CAPT THALMANN: If duration were available, would that help the operators determine risk? If they knew something about the temperature-duration and something about the kind of equipment, then they might be able to distill all this. What it all comes down to is the probability of success. It's all pointing to what's the probability that you are actually going to complete your mission?

LT KAUFMAN: A lot has been said about people being too cold. The flip side is also true, providing too much protection makes it too warm for the operator.

OSCM JARVIS: Right, or limits them in some other way. It's one thing to be warm, but if you can't move your arms—

CAPT THALMANN: You've got to remember that there are maximum limits and there are minimum limits.

LT KASEL: You can get heat exhaustion very easily by wearing a wet suit in 90°F water.

DR. GOFORTH: It seems like the bottom line is, they want to be able to select the right equipment to optimize success.

CAPT THALMANN: Right. The operators may evaluate all information and then go back to R&D labs and say, we think equipment A is better than B, or the salesman just showed us this new wet suit. Can you researchers do a study and tell us if it's any better than what we've got?

DR. DOUBT: There's a lot of discussion about equipment. There are also a number of issues, like diet and nutrition, which are not equipment related. And how would that kind of information be used? It's not a wet suit, it's not a UBA.

OSCM JARVIS: You're talking physical conditioning before the operation?

DR. DOUBT: Physical conditioning, what to eat, what to drink, what not to drink, that kind of general fitness information.

OSCM JARVIS: As long as we stay within the confines of what you would get on any submarine or ship.

LT KASEL: If there was some way we could load it out prior to leaving. You might go out on an operation with just five cases of MREs. That's all you have. You've got to come up with recommendations for things. If we're saying yes, this is what we like to eat, a high carbohydrate diet with Power Bars, or drink instead of plain water.

CAPT THALMANN: It sounds like the problem is we have a report which says Power Bars in some situations are good, but there are caveats. That's no good to you. You want something that just says, eat Power Bars. You can tell your supply people to buy the Power Bar since this procedure says we have to have them.

HM2 PAPPAMIHIEL: You could end up with what happened to us in Saudi. We got over there and we had a van of MREs that expired 3 years ago.

CAPT THALMANN: How did they taste?

HM2 PAPPAMIHIEL: Oh, just lovely.

CAPT THALMANN: Let's get back to how to distribute the data. We just agreed that reports generally are a compendium of information and are not incredibly useful to the operator unless (1) he's willing to read it, and (2) a lot of times he must interpret the data himself. Most investigators do not like to make definitive statements without complete data. In a lot of NMRI reports we have a lay language summary, which is just translating the science to something you can understand.

Does it make sense that within the reports there should be something which is very definitive, which might be a one-page summary titled, Operational Impact? The investigator, without overextending himself, can be pretty specific in saying, based on the data in this report you should do this, this, and this. Does that make sense?

CDR CURLEY: Only if that operational impact statement could be detached from the report.

CAPT THALMANN: All right. Given that is in there, who determines if the operator can do this, this, and this? Do you yourself pick up the report that says eat Power Bars, and without telling anybody, go out and buy a truckload of them?

CDR POLLAND: You can make recommendations. The CO decides whether he will follow that recommendation. He has the authority and responsibility. CDR Butler may need to convene an ad hoc committee of experienced operators to distill that information and put it in the most manageable expression of your recommendations.

CAPT THALMANN: Okay.

UNKNOWN: Provided there's a list of options, comments, recommendations.

CAPT THALMANN: Let's say that your report has items that may impact operations. You list them without saying whether to use them or not. It sounds like there's got to be somebody at SPECWARCOM that reads all this stuff and sanctions it. They would say we think you guys ought to follow the recommendations in this report. Or, that there was some way to validate it.

CDR BUTLER: Two things. One is that each of the teams has always been very independent about what thermal protection they choose. And I don't really see that changing. In other words, SEAL Team 2 would go out and buy whatever kind of wet suits or dry suits they want, as can SEAL Team 4. I don't think there's any kind of an acceptance in the community that we should dictate what kind of wet suit or dry suit each team is going to use. What we have to do is to allow them to make the informed choices. We're not going to be able to go out and make a definitive statement to one team based on just one of these studies. Each study will just be focusing on one small piece of the problem. For example NMRI may be comparing dry suit A to dry suit B. At the same time you might be comparing wet suit A to wet suit B. You have to be able to go back and look at all these different statements and put them all together.

DR. DOUBT: I thought one of the purposes of the entire R&D program is to get a centralized focus of what is best for the teams. Much like the Navy Diving Manual has become for Navy diving in general. It is not an option to dive to 300 feet for 6 hours and come back to the surface.

UNKNOWN: It doesn't tell you what regulator to buy though.

DR. DOUBT: No, but it provides a list of approved regulators.

CAPT THALMANN: We're getting a bit closer. Frank says that SPECWARCOM is not in the business of dictating. But the point is, does SPECWARCOM still want SDV 1 to go out and buy a wet suit because an NHRC report says this wet suit is good, use it? Or, is it saner to have a central focus from SPECWARCOM that would evaluate the report and say, "Yes, this wet suit is okay? This is one of many that's okay." We won't tell you what to buy, but there ought to be somebody that says, don't buy off on this recommendation because maybe it's not a good one.

DR. DOUBT: I don't think scientists are in any position to write an operational impact from their studies. But I do believe that they can say things like: in 6 hours you become hypothermic. That information has to go someplace central that is going to distill it and decide if it's an operational impact.

CDR POLLAND: You can balance this against the Navy Diving Manual. For example, the Navy Diving Manual comes out of the distillation of many different research studies. It is a policy and procedure thing that is driven by safety and other things like that. Fundamental. Basic science, that stands up in court. What we're talking about here is a different situation in that we're talking about research which is constantly changing. It may be the opinion of the body that one researcher may make a recommendation based on his study. Another, though, may find something else that he feels is just as valid. That's not the issue. The issue is that you're still making a recommendation that the teams need to look at. Then you need to sell it to them. How you do that, I don't know. The other thing Frank said is also true. There is an exclusive underlying sensitivity by WARCOM to not meddle in the affairs of the SEAL Teams. I've heard this from the Admiral.

LCDR WOOD: This goes along with the homework assignment provided yesterday. If I went through a report and highlighted sections that were useful to me, I could take highlighted sections and put them on the back of each report. This one line is the same sentence that's in the report, but it's in bulletin format in the back of the book. It doesn't have to say use or not use this piece of equipment, just repeat the statement that you got in the report. For example, wearing thermal protection garments with an underwater breathing apparatus increases energy cost of exercise by an additional 10-30%. Of this whole page of scientific information, that one comment could have gone to the back.

UNKNOWN: Or the front.

LCDR WOOD: Of course, there's a reference to where the paragraph is, because you don't want to take it out of context.

CAPT THALMANN: What you don't have there is the cover letter with that report.

It was our intent of doing it that way, rather than having this operational impact statement in the back. When a report went out there was a cover letter on it. Basically the cover letter said, this report has this information which may be of use to you.

We may also want to agree with what Tom said. It's probably not guys from the R&D lab that should be making the operational impact statements on these reports. Unless they happen to be intimately familiar with certain aspects of the team.

LCDR WOOD: That's why I'd like to see you change that name from Operational Impact Statement (OIS) to something like table of conclusions or table of options. It gets the researcher off the hook for making recommendations to the operators, but at least lists the different general comments in here, the pertinent information.

I don't want to see it in a cover letter for the same reason that Captain Thalmann asked me yesterday. Did I see the cover letter of this report? I said, "No, because in most commands a cover letter gets filed differently than reports do or they get lost."

CAPT THALMANN: How should SPECWARCOM play in this? Is it reasonable that they should be charged with reading these reports and generating OIS? Let them take whatever is in the report and distill that into information. Or do you see that it's going to be at the team level? They are not going to write an OIS, they're going to mentally construct them.

LCDR WOOD: You need to get away from the OIS. That's causing you guys to hesitate about highlighting remarks. All I want is highlights.

CAPT THALMANN: The cover letter looks good, but it's not useful to you guys if you never see it.

LCDR WOOD: Probably what you provided in the cover letter was good, but I never did see it.

CAPT THALMANN: Okay, so you said you would like something in the report which distills the conclusions.

LCDR WOOD: Yes.

CAPT THALMANN: Who is orchestrating all this information? I mean, is every team going to read whatever report gets into their hands and make their own individual decision?

LCDR WOOD: If we get an index of reports, which WARCOM can provide us, we can go through that index and determine which report we want to look at. We then go to the summary of conclusions in that report and see if there's any helpful information in there for

us. If we want more data on that conclusion, look through the body of the report.

LCDR KEITH: All the reports I remember doing at NEDU had executive summaries in them. That's not a requirement?

CAPT THALMANN: Okay. We've already agreed that there needs to be a conclusion or summary in as close to a one-page summary as you can get.

DR. DOUBT: One of the things that is required in all of our reports are key words for purposes of filing a Defense Technical Information (DTIC) document. Is it useful to break those out into a column of key words, coupled with a highlight statement? When you go to a library you can look up key words like diving and hypothermia and they're cross referenced. Is that a useful tool we can use?

CAPT THALMANN: What about the index, should it have key words in it or is it just basically a listing of reports by title?

MS. WOOD: Sounds like we really need something about fleet implications though, instead of conclusions. Something that will relate to what is of interest to the teams.

LCDR WOOD: Well, not if that's going to put the burden on the R&D labs.

CAPT THALMANN: The other thing I'm hearing here is nobody seems to think that anybody should be orchestrating this, that there should be someplace where all reports go, and that somebody goes through them and gets the word out to the teams. It sounds like you all want to make that decision on your own.

CDR BUTLER: Part of the orchestration falls under the overview of what I'm doing at WARCOM. Let me give you a brief sketch of what the plan is for these things. In the next session I'll pass around a compiled list of reports that you were talking about yesterday, Mike. We've got this compiled list of references which are readily available from EDU or NMRI just for the asking. We are in the process of trying to get all these onto a big computer base. I mean, literally at my house right now I have a two and a half foot stack of EDU, NMRI, NHRC, you name it, reports that are unwieldy for a platoon to take into the field. But, maybe they could take five floppy disks and a laptop to pull all these things up.

We're also looking at the concept of biomedical research seminars to supplement what goes on at these R&D conferences. Mostly those conferences are dog and pony shows. It's all the R&D people talking to all the R&D people. There are more operators here than at most of those conferences.

What we need is for guys like Bob Weinberg to show the East Coast SEALS their new hotshot gloves and say here they are, here's how you use them. If you take the time and expense to send researchers to Little Creek with a month or two notice, the guys are

going to be here. They'll get this information, and I think the research side of the house has made a maximum effort.

LCDR WOOD: That's a key point you just brought up. If WARCOM is the central clearinghouse for all the R&D, then researchers would get their test plans approved with WARCOM, and WARCOM tells the teams to support this investigation. I can't speak for other commands, but I can speak for our command. When it is designated ahead of time we do put the people aside.

CAPT THALMANN: So, you expect WARCOM to act as a coordinator between the teams.

LCDR WOOD: Either that or the Groups.

LT KASEL: Just an example of that. We supported a night vision study. A guy came down with goggles and about 30 operators played with the gear. He said, "Is there anything you'd like to test?"

We said we wanted to test this, and this. This company sent us a prototype. We field tested it and came back and said, "It didn't work," so try again.

Another time, SDV Team 2 evaluated weapons for the SEAL teams on the East Coast. You put it on the back of an SDV and you leave it there for a couple of days. We used to dive it, we used to drop it, we used to beat it, we'd take it out on deployment for 6 months as a test and evaluation period. On returning, we'd say if we liked it. Here's what we want.

CAPT THALMANN: It sounds like that WARCOM also ought to be the repository for all this information. Can reports get distributed to everybody? One would expect that WARCOM would have maintained a file of all the reports in case you lose your copy or in case you didn't get one.

UNKNOWN: Either that or the Center would do that.

CAPT THALMANN: Okay. This is a method of distributing the information. But how is the information going to be used to actually turn it into operational procedures? Is that going to be at the Group or Team level or is that going to be at the WARCOM level or is it going to be on all three levels?

CDR BUTLER: I think that depends partly on which specific item we're talking about. I'm going to give you three different examples. Let's say that when Dr. Goforth completes a study on current thermal exposures in special warfare operations and he finds that a particular operation winds up with half of the guys with core temperatures under 35°C. That's going to come into WARCOM and may get some action from WARCOM.

We may not leave that up to the individual teams to decide if they will continue to do that exposure. If something is determined at WARCOM to be a pressing safety issue, then I think it's got a reasonable chance of getting some action through the medical shop at WARCOM.

Example two would be comparing wet suit A to wet suit B. WARCOM is not going to intervene in the wet suit A versus wet suit B battle. The information will be out there, it's up to the researchers to give the teams a good enough basis of information to make an intelligent decision.

Example three would be that Dr. Kelleher is testing the DATPS at EDU and finds that it is no better thermal protection than a dry suit but it's eight times as expensive and requires two extra batteries on the SDV. Well, it's entirely possible that WARCOM may say, if the DATPS isn't any better than the dry suit, then why do we need to spend all this money and tie up our battery space in the SDVs? So, that's another instance where WARCOM might take a more active role.

CAPT THALMANN: But still, it's the command that has to take a central role in this. Some of the decisions will be made locally. For example, there are 10 different wet suits that work, pick the one you want, based on whatever the operation is. Other ones were made at the command level, where they might say this procedure is dangerous or this piece of gear is no good, don't use it.

But it looks like that within the command there's going to have to be either an individual or a group that's going to be responsible for keeping this information at hand, having some way of organizing it, and staying abreast of what decisions are being made using the information. Certainly somebody at WARCOM ought to know if SDV Team 1 is purchasing dry suits based on some report. Or that somebody else has, in fact, gone out and, based on another report, bought specific temperature gauges so that they can register temperatures when they go on their operations. You might not want to influence that decision, but you might want to know that it's being made and how it's being made.

MR. DUDINSKY: Both Group 1 and Group 2 have an R&D shop. Typically any equipment evaluation that takes place is done in cooperation with the Group R&D shop. That's probably the most logical place for people to stay up-to-date on what's happening with the medical community developments.

CAPT THALMANN: Did you get the reports?

MR. DUDINSKY: No, I don't get the reports at this point.

CAPT THALMANN: Okay. Why?

MR. DUDINSKY: I have no idea.

CAPT THALMANN: Okay. So there's an R&D shop in the Group, but they're not getting the reports. Even though guys at the Team level are.

LCDR WOOD: Group R&Ds are very responsive to the Teams. You might want to have all the studies come into WARCOM because the WARCOM R&D guy will be working with the Group R&D shops. So, you are still saying the same thing. The actual reports may be held at the Groups, but they were routed to WARCOM.

CAPT THALMANN: Let me ask you this. When we send a report out we also attach a cover letter to it. At the bottom of that letter is a distribution list. Does anybody at WARCOM look at that distribution list and say, "Aha, these guys should get this report? The investigators didn't put them on the list." My impression right now is, that doesn't happen. That the report gets sent to whoever is on the list. Nowhere in the NSW community does anyone review the list and say this report ought to get into these guys' hands. They can use that information.

CDR BUTLER: Not only that, but if, for example, SEAL Team 4 gets one copy it probably goes to the intel shop or to the XO or whoever. The platoon commanders may never see it.

CAPT THALMANN: Would you agree that one of our recommendations should be made to WARCOM that they should set up some kind of a procedure to review these reports and make sure they get into the right guy's hands. Not even to comment or to influence the user, but just to say, I want to make sure that this information is getting into the right hands.

CDR BUTLER: That's a good idea.

CAPT THALMANN: We could at least then have a way of making sure these reports get circulated. Who should that be? Should it just be a generic recommendation or should it be more specific? Should that be in your shop? Should that be Cal?

CDR POLLAND: I'd like to respond to that. I want people to understand there are currently no staff to do any of this stuff you're talking about. Absolutely none. I have no one that can keep this stuff on hand, organize it, respond to multiple phone calls. Frank Butler is physically located in Pensacola, FL. I am traveling a lot.

CAPT THALMANN: All right, there's a whole bunch of reasons why this could be a pain.

CDR POLLAND: No, it's not a pain, sir. It is not going to be done unless some upfront dollars are dedicated to the hiring of additional staff so that this stuff can be properly organized and coordinated with Frank Butler, who is the designated medical R&D individual for NSW Command.

CAPT THALMANN: What you're saying is we don't have the resources to implement this recommendation.

CDR POLLAND: Absolutely not.

CAPT THALMANN: All right. But that doesn't necessarily mean it's a bad recommendation. It just means that you don't have the resources to implement it.

DR. DOUBT: If the Coronado area is at all like the Washington, DC area, there are contractors who are trained in distribution and coordination. My guess would be that less than one percent of the total SPECWAR R&D budget would bring somebody in like that to do the job. So, it doesn't matter who's on TAD.

CAPT THALMANN: Okay, but right now the way it is, Tom Doubt makes the distributional list for his report as best he can. Hal Goforth makes his own list for his reports.

LCDR WOOD: Strategy and Tactics at the Center is the agent for all the TAC memos, to make sure that they get disbursed to the teams as an agent for WARCOM. Maybe this same situation could be set up for all these research reports.

UNKNOWN: They have less people than we have.

LT. KASEL: Well, we've all made excuses why we can't do it, but there's plenty of reasons we can do it. If you look at the team areas currently, there's a lot of JOs sitting around. We could send a Lieutenant over to Tactics for a couple of years to do this. All he does is distribution. You know, there's plenty of people out there to do it.

CDR BUTLER: There are two things. One, we have eight platoons in each SEAL Team, an intel shop, and the front office. So, we need to send 10 copies to each operational SEAL team. Number two, even if you do this, what's going to happen? Do you think that that a platoon leader is going to turn it over to the next platoon leader? No, usually he's going to take it with him as part of his loadout when he goes to his next command. So, the ultimate answer is, every 6 months to a year we need to update the computer library on all these reports. CAPT THALMANN: Who sends that out?

CDR BUTLER: WARCOM will ultimately send it out.

CAPT THALMANN: It's still coming back, in principal, that we recommend WARCOM come up with some reasonable way to make sure these things get distributed. A distribution list is something we could come up with as a result of this workshop, so that the investigators know where to send reports.

CDR POLLAND: I'd like to see this come to fruition, but if you're talking about

using my office, that cannot happen.

CAPT THALMANN: Wait a minute now, let me put this back in perspective. I'm not up here to sell you on how to make life easier for Teams. What we're trying to do is to figure out how we can best take the information that we generate and get it to the user. I don't particularly have any way in mind. But right now it seems to be done in a haphazard manner. Sometimes reports get into the right hands, sometimes they don't.

CDR POLLAND: No dispute on that.

CAPT THALMANN: Certainly this distribution list is a first step. If you come up with a decent one you can say, well, at least it's the first cut. You got it into everybody's hands. But then a second problem exists. Is there anybody else we might call and say, you might be interested in this report.

CDR BUTLER: Well, if we're saying WARCOM, I think that's creating misconceptions. I'm not looking at you or me or anybody else at WARCOM moving big loads of books and acting as a publishing clearinghouse for these reports. That's unwieldy and not workable. I'm talking about working through Frank Lauria's shop at 06-Z or NCSC and getting one of their people who can offer computer services. I would tell these guys, every 6 months to a year, we want an updated list of all the biomedical reports put onto a floppy disk. We send these floppy disks out to the Teams. The Teams can then copy the floppy disk a thousand times if they want to. I'm not talking about having anybody at WARCOM physically take charge of distributing these reports. It would be something that we would pay somebody to do.

CAPT THALMANN: How does your shop fit into this? I mean, do you get copies of these reports as they're pumped out?

LCDR LAURIA: We do because we have the money and we all have received a program.

CAPT THALMANN: What do you do with them?

LCDR LAURIA: Right now, my copies sit on top of a safe. We could be responsible for reviewing the distribution list because we do it on a lot of other things, like the technical manuals that go out for diving equipment.

CAPT THALMANN: In summary, we can draw two conclusions. One, there exists no formal method of distributing these right now. It seems to be informal.

And number two, SPECWARCOM should consciously decide on a mechanism for doing that. Then it is simply a matter of making sure that every 6 months the R&D labs get an updated distribution list. Someone would send out an updated distribution list to the lab

and say, whenever you get a report that has anything to do with the Teams send it out to these people. Internally they can set up whatever mechanism they want to keep themselves informed. As these reports get to the Teams they know what they're being used for and if they're being used. You would certainly like to know if the research money is coming to fruition.

The chances of the R&D command doing this are pretty slim. And the main reason is they probably aren't tuned to the community that all those reports should go to.

CDR BUTLER: Ultimately we envision a much bigger base program than just the Navy R&D commands. There are tons of things being published in the Army and the Air Force that are of potential interest to us as well.

CAPT THALMANN: Okay. So, one, right now the current distribution of information is informal.

Number two is that it should be formalized.

And number three is that SPECWAR needs some kind of internal distribution system.

So, we should say that these reports should come out with either an executive summary or some kind of reasonable conclusion page that's attached to the report, so it doesn't get separated from the report.

In principle it's probably still reasonable to send them out, at least with a cover letter, if for no other reason than to document where the report went.

CDR CURLEY: I think we've come full circle, but we still haven't answered one of the basic questions we started with. Which was, interpretation of data and what makes it useful? When I read some reports I have to go back to the author to help me interpret what he wrote. I have concerns about the operators getting this flood of reports and having to distill them, even with the bulletized summary. They need somebody to turn to.

CDR BUTLER: That's where the concept of the biomedical research seminars comes in. I mean, once or twice a year you have somebody who's in charge of picking six or eight people who have important information that they need to get out to all of the Teams. The medical R&D command or O6-Z or whoever would set a time and a place for these guys to meet with all the SEAL Teams; to show them how to work the new active thermal protection gloves, to show them how to work the new DDS atmosphere controls, or to have Dr. Thalmann show them how to use the thermal garment selection criteria. They could actually sit down with the researchers. You know, one on one with the investigators.

CDR CURLEY: I think that's good, and it addresses the new information. But we know that there are probably 500 or more technical reports that have been published in the

past that have some relevance to special warfare operations. Some of those reports are written at the esoteric level. Where do I turn for interpretation of the five or so reports on hyperthermia?

CDR BUTLER: These seminars are incredibly flexible and they are a learning process in and of themselves. You have to figure out what the teams need to know and what things are best presented at these and which are not. For example, if those guys don't know how to use Ed's thermal garment selection criteria, then it's no good and you might as well not have bothered writing the thing. It's a waste of time and effort.

On the other hand, for example, your study on measurements of special warfare-related performance may not be important for Mike Wood to know, because we may be able to incorporate that at the researcher level and say, okay, we know that these tests are probably representative of our best approximation of the skills that you need to drive an SDV. What would come out in the report would be these SDV-related performance skills. But it wouldn't be important for the guys at SDV 1 to know how you arrived at those measures or even what those measures necessarily were. You would just summarize the skills on SDV-related performance.

CAPT THALMANN: So, this is a method of distributing and interpreting some data and if it's focused, it's fine. Here is a procedure from NMRI, here's how to work it. But who provides the interpretation of maybe the last 3 years of human factors that has been done at NMRI and NHRC? How do I get these guys to put this together into something that I think is usable?

CDR BUTLER: If there's demand from the Teams for more information on human factors, then we incorporate that into the seminars.

CAPT THALMANN: It also sounds like you're expecting the investigators to provide a lot of that synthesis.

CDR BUTLER: When we're talking about "synthesis of human factors level," how is that going to be translated for an operator? I'm not sure I'm tracking here.

CAPT THALMANN: Let's say, as an example, that there have been ongoing studies of measures of performance under certain conditions. Is there any way to take on all this information and put together a comprehensive test battery that I can take on an operation? That's going to require somebody to do a lot of homework. There are a couple of ways to do it. You can ask somebody to do it.

Number two, you could do it. You say, I'm pretty smart, I'll sit down and read all these reports and write a memo to SPECWARCOM saying that I think that we ought to come up with this test battery. Specific reports aren't too bad, you know. You can evaluate a specific piece of thermal gear and provide specific information in a format that a guy like

Mike Wood could sit down and intelligently choose the right gear for the right job. It's when the information begins to appear from more than one place that you run into that problem. And some of it will.

LCDR WOOD: Typically, if the team has an interest in a particular issue that is in a report and we don't understand it, we'll go to our R&D rep at the Group. On many occasions we've even gone to the author of the report and asked specific questions. Now, is that the right answer? I don't know, but I'm telling you that is what we do now. We don't just let it stop at the point that we don't understand the information enough to make a decision.

DR. GOFORTH: But it still takes interaction. If the investigator can come down and present to the platoon that's in training, they can have it out with him right there and ask all the questions they want about how the study was done, and why does he recommend this. But you have to be there at the right time. You can't just show up one day.

CAPT THALMANN: Well, in fact, that's a very similar concept.

DR. GOFORTH: But it's focused to work with the platoon that's in training, not just show up and give it to whoever is there that day.

CDR CURLEY: One last comment. As an investigator, I think we all have our own bias and our own particular bents. I think it's in the best interest of Navy Special Warfare to have somebody that's owned by Navy Special Warfare be an independent broker to synthesize all the R&D material. I think all the investigators are very honest in presenting what we think are the answers and the solutions. But those of us in R&D know that different investigators disagree about very fundamental ways and means of doing things.

UNKNOWN: But there's nobody there yet.

CDR POLLAND: I think it's a good idea to get the investigators to come out and speak to the operators, probably an ideal situation. And do it on a routine basis. But I also know that there's been reluctance to fund such a meeting. I would therefore recommend that you have an alternative for that.

You understand what I mean about that may not be funded. I'm saying for you, on record, that I would support you a 100 percent.

CAPT THALMANN: That's a matter of establishing a feedback route. So the guys at the top of the heap know that the guys at the bottom of the heap are in fact receiving some benefit from the money they're spending.

Let's see if we can wrap this up. I think we've gotten a better handle on what exists and what doesn't exist for information distribution. I think, at least, as a result of this

conference the next reports that come out of any of the R&D labs can at least initially get into the right hands.

There's a handbook which is in the mill. Does anybody see that of any use? Or are the operations trying to be so different and so flexible that trying to come up with standard operating procedures is almost impossible?

CDR BUTLER: Mike, is SDV 1 currently typing up the combat diver handbook with the two chapters, one on the combat diver decompression procedures and one on combat diver operations?

LCDR WOOD: I don't have the answer to that.

CAPT THALMANN: Okay, what about more rapid distribution? For instance, NMRI gets tasked to do a study on pyridostigmine and hot water diving. They turn around and send the message out saying, we did this study and here's the results. Right now there appears to be no formal distribution system for doing that. Should there be? Or do we think that the distribution list of reports will take care of that?

DR. DOUBT: I can speak from personal experience in distributing the message on pyridostigmine to operational units. The message went out to a particular EOD group. About 2 months later I got a call from the same group; they said: "Remember when you were going to do this, well, whatever happened to that?"

It would be easier to get a 30-second spot on CNN than use that message traffic for information.

LCDR WOOD: I don't agree with that at all, because if you do it in the AIG type of format it may not get to the right individual that was looking for it. But if you had AIGs required to be filed, all a person has to do is go back and refer to that AIG file. I guarantee you, if we've got a diving inspection coming up and we go for our diving AIGs they're all there. And if there is some type of medical file that's in the AIG format, that individual may call the author because he hasn't looked in the AIG file. That doesn't mean it's not at the command.

CAPT THALMANN: Somebody would know about it.

LT KASEL: I know at least four people that look at the messages. Our operations boss reads it as soon as he gets it. The XO looks at it. The CO generally looks at it, if he's in town. And then if it's a piece of equipment they'll bring it up to supply the diving locker. They say, hey, there's a new regulator out and they say it works great in cold water. Okay. Well, let's take a look at it and see if this is something we need to buy. And a lot of times all the platoon officers that are in town and the training officer will also look at that message.

CAPT THALMANN: What we didn't cover is the actual format of what Frank wanted to come up with. Based on yesterday's discussion of all the performance measures, I think that we really need to think about that some more. We're getting the impression that the operators would like this in some kind of a format that they can put to use. They don't want things too quantitative, but they need bottom lines.

We did hear one suggestion to put out a "consumer's report" format. And maybe that's not as farfetched as it sounds. But my impression is, that is going to take a little bit of homework. And I think that's where MOD-1 is going to come in. Based on this meeting, we'll develop MOD-1 and come back and say, okay, here is how these executive summaries and reports should be laid out. Based on that maybe another format will evolve from things like an equipment evaluation summary, laid out from an R&D project. So you understand what it means.

UNKNOWN: I have a question. On that report you just mentioned, what was its title?

UNKNOWN: Pyridostigmine in Diving.

UNKNOWN: Do you know what that means, Mike?

LCDR WOOD: No, I don't. Can I suggest that we start tilting our reports for the user, so that they understand what it is? So that can determine whether they want to read that report?

UNKNOWN: This tasking came from people that used pyridostigmine.

LCDR WOOD: Yeah, but if these guys are going to make use of it, they need to know what it means when they're flashing through their list of reports.

REMAINING ISSUES SESSION

CDR BUTLER: A couple of folks yesterday were interested in trying to obtain a compiled list of all the biomedical reports which pertained to special warfare. I have that list here.

This list has a date on it so you'll know if you've got a current copy or not. It's broken down into general subject data.

I realize this is a partial list, but it is a starting point.

CAPT THALMANN: Some of these reports are not the kind of things you can easily put your hand on. So, if they're on this list, then they ought to sit someplace.

CDR BUTLER: Ultimately the idea is to get everything that's on this list onto the computer so that it's available at the platoon level. Exactly how that's going to get done, I'm not sure yet. But I'm working on it.

UNKNOWN: Have you guys ever considered publishing report abstracts?

CDR BUTLER: The Undersea and Hyperbaric Medical Society has a very large service that does that, but it only pertains to diving things. It doesn't pertain, for example, to prevention of traveler's diarrhea or jet lag. A second issue that came up yesterday was, tell us what kind of projects you have going on.

Handout 2 is a list of those projects, as of May. Again it's broken down into basically the same categories that we talked about before.

Again, this is something that we'll probably update extensively. So if you guys have studies that you know about that you would like to add, I'd love to hear about them. We've had a little discussion upstairs last night about exactly what we thought this format might look like. And I found myself in a minority of one discussing these issues. So, what I want to do in about 45 minutes is to recap some of the things that we've talked about. Make sure that we're all on the same track one last time.

Again, this list of standard thermal protection indices is not designed in any way, shape, or form to curtail the initiative or the autonomy of the initial investigators. We're not telling these guys how to do their research. We wouldn't suggest it and they wouldn't stand for it, nor should they. What this is, is a way to take a certain small segment of what they do and to put that to the teams in an understandable format. And the idea is that the format would be similar for all the different studies that we do in the thermal protection area.

Now, let me recap some of the studies that we're doing in the thermal protection area, and then I have a strawman of what this standard list of indices might look like. And we'll compare and see how they match up and see if they seem to be what the majority of the folks here would like to see.

Evaluation of Thermal Protection and Current Naval Special Warfare Operations—Here we're not comparing wet suit A to wet suit B. We want Hal Goforth to tell us whether our people are in danger of hypothermia on any of these operations. That's a question that was raised after the hypothermic incident. We exceed a lot of the published guidelines for recommended thermal exposures, and we know that. On the other hand, we've been doing them for a long time and for the most part we do them very safely. But we do need to go out there and do these measurements and be able to say, these people are or are not dangerously hypothermic.

Radio Frequency Warming Techniques—Using RF radiation to warm people more effectively than electrical resistency or a dry suit or a wet suit.

Factors Effecting Performance In Cold Immersions—We have to be careful in thinking that all these performance degradations that we're seeing at the end of a long cold exposure are due entirely to total core temperature drop. It may be that your performance falls off as soon as they throw you in 30°F water. That puts a different flavor on it than if the performance is off because you've been in cold water at 30°F for 4 hours. There are a number of other things that could account for these performance detriments. And it's going to be up to NMRI to try to help sort that out for us.

Thermal Garment Comparison Study—Somewhere down the road we are going to want to compare dry suit A to dry suit B to wet suit A to wet suit B to the DATPS. We're probably looking at undertaking that in FY93.

The DATPS Evaluation—NSW is spending a lot of money on the DATPS and we want to make sure that we're asking the right questions when we go through and evaluate this system to compare it to what's currently out there.

Effects of Cold Immersion on Performance and SDV Operations—Drs. Prusaczyk and Goforth are working on this at NHRC. These investigators have access to Special Warfare Center's SDV trainer. It would tell us a lot if we can go in there and see the mistakes the operators are making in their SDV performance and then be able to turn around and administer them the same battery of performance tests that we're going to be using for the thermal protection indices and see if there's a correlation. Theirs is the first study that will give us feedback as to whether what we're doing translates well into real operational situations.

So, with that background, and bearing in mind that these indices are going to have to work with all those different situations, let's look at this summary coming out as an appendix to a bigger report. All the data are there. Whatever the investigators want to put in there is there and in whatever format they want. And in whatever detail, using differential equations and language that the operators may never hope to understand. But somewhere in that report there is this one page that says, "Look, guys, this is for you. This breaks it down."

We're going to want to know the water temperature. We're going to want to know what the diver was dressed in. You want to know where the study was done, so if there are questions you can call back and ask. We'd like to know what report number the summary correlates to so that if you want to go back and obtain additional information on a specific area you can go back and refer to the full report.

We want to know their activity. Were they at rest, as would be the case when piloting an SDV? Or were they exercising the entire time or were they just exercising part of the time?

Maximum exposure time: Now, let's say that we have picked 8 hours as our maximum exposure time. Now, there are two ways that we could go here. We could either

say that we totally disregard any exposures that had to be stopped before they reach 8 hours. What can cause you to stop before you reach 8 hours?

First, in the studies that are done in the laboratory, the experimental subjects have the option to quit as soon as they get cold. Subjects exercise that option on a not infrequent basis, because these experiments are not fun to do.

Second, there could be some sort of a non-thermal garment-related experimental problem such as a data collection malfunction. The investigator may decide to stop the exposure on this basis.

Third, there could be a suit-related failure. You've got on a dry suit and it begins to leak and the experiment is terminated for this reason.

So, what are you going to do with these exposures where the exposures are not to the maximum time? If we're going to include those in this format at all, then we have to record the time at which the exposure was stopped. What that does is enable you to obtain some information even on the exposures which were aborted. For example, take shivering. Let's say that the subjects who went all the way to 8 hours were 100 percent shivering. On the other hand, subjects who stopped after 4 hours, for whatever reason, were not shivering at all. So, that tells you that this system gives you very good protection up to 4 hours, but starts to fall a little short when you hit 8 hours.

Mean core temperature: We need to ask this question once more. It was my understanding, talking with the investigators yesterday, that the operators felt that mean core temperature was not something that you have to look at. We need to discuss this further, I think. It seemed that the consensus was that the operators did not necessarily want to see a measure like mean core temperature at the end of the exposure or core temperature drop on this standard set of indices.

OSCM JARVIS: Talk about some interpretation, if you say core temperature dropped so many tenths of a degree would that mean anything to us?

CDR BUTLER: Well, what if you had a mean core temperature drop and a low core temperature?

Does everybody know what the normal temperature is? How cold is dangerously hypothermic?

UNKNOWN: In our language or in your language?

CDR BUTLER: In any language. How cold is dangerously hypothermic?

UNKNOWN: 96-97°F.

CDR BUTLER: Actually, the most accepted figure is 95°F, which is equivalent to 35°C. You're not going to die of a core temperature of 35°C, but enough people have reported that definite mental or cognitive detriments take place at 35°C so that it has been accepted as a universal cutoff for stopping these experiments in the laboratory.

LT KASEL: I can look at a guy's eyes, the pupils are this big. That to me means his core temperature is 95°F. I can't take a core temperature out in the field. I would just like to know if his core temperature is 35°C. Say his skin is white. His pupils are dilated. His respiration is about 60. That's useful information to me. That's a core temperature to me. A core temperature out in the field.

CDR BUTLER: Special Warfare personnel would never have to take a core temperature during an operation. Our field studies would be designed to have the investigators measure core temperature at the end of the exposure.

LT KASEL: I usually carry a rectal thermometer out in the field.

CDR BUTLER: Again, you don't have to worry about figuring out what their core temperature is. The question is how to make the number which will be reported to you meaningful.

CAPT THALMANN: I think what everybody is saying is, if you take your core temperature and your performance measure, and both were presented together, that's useful information. But core temperature by itself is not. But both together may be more useful. Measuring core temperature is no big deal. It's easy to do. What operators want to know is, what does it mean?

LCDR WOOD: It doesn't hurt to have it. I mean, eventually you'll develop the relationship between core temperature and activity level.

DR. DOUBT: My sense of what came of the performance session yesterday was that if you present just a temperature and report a value of 35°C, you know you have a significant problem. But remember that Dr. Thomas said yesterday that a drop in core temperature as little as a couple of tenths of a degree can affect your cognitive performance. That may be significant to the operator, not just to the point that somebody has a major problem.

CAPT THALMANN: Well, as long as it's stated in the summary.

DR. DOUBT: You need some interpretation.

LCDR KEITH: Exactly. You need, like Dr. Thalmann said, to have it related to performance criteria. Otherwise it's just a temperature.

CDR BUTLER: Let me give you an example here. Let's say that we take Dr. Curley and use him as an experimental victim on a study for an amazing new wet suit that's going to protect you more effectively than any of its predecessors. We're going to test it in 35°F water. Okay? We take Dr. Curley, drop him in the wet pot at NMRI. At the end of 20 minutes, he says, "I'm out of here." His core temperature may still be 37°C. It may not have dropped a bit.

On the other hand, his performance may be way off the scale. There may not be a direct correlation between the core temperature that you're going to see and the performance. However, the core temperature does give you a measure of safety. If Mike Wood is the XO of SDV 2 in a few years and he looks at one of these studies and says, "Hey, three of the guys here had a core temperature of 34.4°C. That's unsafe, I'm not going to let my guys experience this exposure." It does have safety implications for the people who are the team management.

LT KASEL: You just said, they did this thing and they were 34.4°C. I think there's going to have to be performance related to core temperature. Because if you open the book, it says his core temperature was 34°C. Well, why was it 34? He swam 8 hours in a Phase 1/ Phase 2 in the open ocean. There's your performance. At 6 hours his core temperature was 36°C. So, yes, I can swim Phase 1/Phase 2 for 6 hours and be safe. That's how I'd use that core temperature and its relation to performance.

CDR BUTLER: Okay. Moving down. Should we put low core temperature in there? From a safety standpoint would the operational commands want to see what the low core temperature was for a given exposure?

LCDR KEITH: As what though, Frank? Low core temperature would more than likely be at the end of the exposure.

CDR BUTLER: All of these measures will be taken at the end of whatever exposure the people had. This zero to three is not meant to track the core temperatures of the individual people. For the people, for example, who stop their exposures at 2 hours, the one-to-two column would tell you what their core temperature was.

DR. DOUBT: Low core temperature correlates to performance as well as rest activity cycles. So, if you have a number out there that says, he was at 36°C after 6 hours of continuous swimming, that has a different interpretation than if he was at 34°C after 6 hours of rest. So, I'm not sure how you are going to use that number.

LCDR WOOD: I think the core temperature number needs to relate to the phase of the activity. At least from our core temperature perspective.

CDR BUTLER: At the time that they take the temperature everybody will be at rest. It won't be in the middle of any activity. But your point is well taken. For example, if you

had a schedule that was completely at rest there'd be no problem. If you had a schedule that was completely working, there'd be no problem. But what about a dive where you have work/rest cycles? You just have to spell out what the activity was and clearly define your work/rest cycles.

LCDR WOOD: I've got a question then. If I have a passive period, then active and then passive again, is my core temperature the same through passive and active periods?

UNKNOWN: NO.

LCDR WOOD: So then, low temperature is just like maximum depth on the dive. Your last part of the dive may not be your maximum depth. In some of our operations we may have long periods of inactivity in a middle period—or long periods of passive activity and short periods of high activity in the middle. So, our low core temperature may be at a different portion of the operation.

CDR BUTLER: You're 100% right and you would have to spell all that out in the activity part. Knowing what the core temperature was at the end of the exposure you'd be able to look at what the activity profile was and judge that. If it was completely at rest, no problem. If it was completely working, no problem. It's only if they were intermittent work/rest phases that you may have to look a little closer.

I see heads shaking out there. Let's talk until we get this ironed out.

DR. HYDE: That's not enough information for the operator. You're telling them that you're only taking a core temperature at the end of the exposure? That doesn't give them enough information to be able to use that number.

CDR BUTLER: What's your suggestion?

DR. HYDE: My suggestion is to very specifically relate it to time of exposure. You can't just say, "We have work/rest cycles," and then give them a number that was taken at the end of the exposure. That doesn't tell them what happened during the progression of those work/rest cycles. If their core temperatures rise during work, but then drop to a dangerous level during rest and then come back up during their next work cycle, that doesn't tell them that there's a problem with core temperatures during that intermittent work/rest cycle.

CDR BUTLER: Bear in mind that in the field studies all of their exposures will be essentially all resting or all working. An SDV exposure will be almost all rest.

DR. HYDE. But you're talking about a particular study where you're trying to condense the information for the operators to interpret.

LT KAUFMAN: I disagree with what he said about that, sir. A typical operation in my estimation would be a resting boat ride and transit across the beach, active patrol, a resting layup, active time on target, a layup period, an active transit across the beach, and a passive boat ride back. So, I think it's not fair to say that it's just quite so segmented.

LT KASEL: Same thing with the SDV. I've seen the pilot and navigator inactive. They drove and then dropped off the swimmers, the swimmers did their swim, and those guys were sitting in the SDV freezing to death. The swimmers did their ship attack, the SDV comes back around. The swimmers get picked up and go for another 3 hours inactive. Then you're active when you're launching and recovering, too. So, you've got activity, inactivity, activity, inactivity, activity.

LT HART: My recommendation is if you're going to put your time scales up there you can follow along. If they quit at 3-4 hours, why not just go ahead and do the thermal measures? We've got the technology to do it, you can include it in the report. So, if you had an activity period, your core temperature was this, after the rest period the core was that. You can avoid throwing that data away and only going for one data point.

CDR BUTLER: Again, nothing is thrown away. All the information that you're mentioning and all the information that Dave Kaufman is talking about is all in the body of the report. Now, if we're talking about a one-page summary, I'm completely open to put those in there. But how are we going to go through and put all these different temperatures at the ends of each different transition period in a one-page summary for these different types of exposures.

CDR POLLAND: Was your intent, though, to go ahead and wire them throughout the entire experiment?

CDR BUTLER: It'll be a mixed bag. All of the studies that will be done in the laboratory will be wired the whole time, but many of the studies which are done in the field may not be wired the whole time. For example, doing the surface swims at BUD/S, you're not going to be allowed to put rectal probes in these guys for the whole time that they're out there swimming. Those guys are out there to pass the 5-mile swim, and neither they nor the instructors will allow anything that might interfere with that.

So, information all the way through the course of the dive in the field studies won't be available.

DR. DOUBT: In field studies like the BUD/S swim, you aren't going to be able to instrument anyone, so you may never know when the lowest core temperature occurs. On the other hand, if we simulate this exact swim in a laboratory situation, with continuous monitoring, we could come up with a different low core temperature for the same exposure and the same activity level. What it boils down to is whether you can take a measurement that means something at a particular time. I would suggest that in field studies it can be

quite difficult to do. I thought the report was going back to the operators in a format that, one, should they attempt this operation? Two, if they do, what's going to be the outcome? Can they do it?

And my sense from yesterday was that part of the information doesn't require core temperature. What it requires is performance.

CDR BUTLER: Now, let me give you an example. Let's say you go out and take part in this 5-mile swim with the guys at BUD/S, and you come out incoherent with a heart rate of 30. They take your temperature just before you die and your core temperature is 31°C. Well it might not have been 31°C the entire time. It might not have been 31°C an hour ago. That's true, but that isn't what the Admiral's going to be asking. He's going to be asking, "What was this guy's core temperature when he died?"

For safety issues, we've got to know what their core temperature is when they finish the operation.

DR. DOUBT: I don't think you'll know that. Asking the core temperature at the point when a person dies is like asking what the person's heartbeat was when he died. I mean, they're dead.

CDR BUTLER: Okay, before they die. Let's say that they take the core temperature as they're taking him to the emergency room in the ambulance and they get a temperature of 31°C.

DR. DOUBT: But on the other hand, suppose you don't use core temperature in your reporting format, suppose you use the performance rating. Hal goes out and times the swims and documents those people that staggered up on the beach versus those people that run up. He then goes back and does the laboratory study where he continuously monitors the core temperature and says, okay, we've got a correlation here. Those people that staggered up on the beach have a low core temperature. He makes some association with the body composition or a percentage of people who are able to do this without running the risk of hypothermia. The report back to BUD/S might say, "Okay, you can expect that on a 5-mile swim in 50°F water, 10% of your people are going to develop difficulties."

LCDR WOOD: Back to your original question of whether we, as operators, want that information on this report for safety reasons. If that temperature was taken on a continuous basis I want to know the lowest core temperature, regardless of whether it's the end, middle, or beginning. Maybe you can put an indicator in the report saying whether temperatures were monitored continuously.

Now, if it's one of those field studies where you can only take the temperature at the end, then of course, that is the lowest core temperature that you recorded. You indicate that this was a one-time measurement. Just like maximum depths on the dive, I'd like to know

the lowest temperature, not necessarily the temperature at the end.

UNKNOWN: You want it related to when it happened on the report?

LCDR WOOD: He tells it in a one-page portion, "Here is the lowest core temperature this guy reached on this dive." Here's an asterisk that says there was a continuous temperature. I can go to the body of the report now and look up the graph and it shows me what phase during the dive this guy reached this lowest temperature.

LT KASEL: Yesterday we were talking about body fat and how they came up with the measurements. Well, I remember when that report came out, it was nice, in a little booklet. I can look at the graph and see why they did it.

OSCM JARVIS: Well, the only thing we're really concerned with, again, is performance. But you've got to know core temperatures at the end for safety reasons. This is just information you're putting out on this end. So, we need something that's useful for judging something was safe or not.

LCDR KEITH: We were doing a surface swim. Right in the middle of it a guy stopped swimming and passed out. There wasn't anything performance-wise that you could say that he was doing incorrectly. It was at that point that there was a problem. And he was already essentially incapacitated.

DR. DOUBT: But how can we use a study of rectal temperature in 500 swimmers as a criteria of whether you're going to do the swim or as what you're going to look for during the course of the swim.

LCDR KEITH: That's predictive vulnerability.

DR. DOUBT: The other aspect of that is you may have somebody with a core temperature of 35°C who is thinking pretty well compared to somebody who is 36°C and is completely fogged. We see this a lot in our thermal studies. Using the probability of success, I think, has a certain appeal. A number of us talked about that yesterday. If you get an evaluation sheet that says the probability of a person completing that study without being significantly impaired is 95%, then you know 95% out of 100% of your guys should be able to make that swim. On the other hand, if we say the probability is 50%, then you know half the guys aren't going to be able to make it. That's independent of whether you know exactly what core temperature was.

LT KASEL: I have a question of the researchers about core temperatures. How important is a core temperature? What about running habits, diet, sleep, coffee drinking? Maybe he had been drinking a lot of coffee the last 6 hours, his core temperature is 98.6°F. He jumps in that water and all of a sudden now he's down to 96°F. How important to the researchers is knowing what he's had the day and a half prior to his swim?

CDR CURLEY: When we talk about the different stressors, and their additivity and synergism, those issues need to be addressed. When we're talking about doing an operation they need to be factored into that equation. Whatever system we decide to come up with becomes more sophisticated as more information is fed into the reporting format. Probability of success, physical fatigue, sleep deprivation, the rest of that, are things that 10 years from now, you'll pull up on your computer and you'll say, I expect our fellows will have 8 hours of sleep deprivation. I think we need to decide what's most important initially. "We" being you, the operators, and let us help get that information. But that's a very important point, that nothing is in isolation.

LCDR WOOD: Again, the focus is going to be, can the operators use this? I'm going to say that we can. What I would look for is a graph of a core temperature profile that gives me the low and the mean. That tells me, hey, here is the low period. I can find the periods of most danger. If you also tell me this is a core temperature profile using a Phase 1/Phase 2 and I see these low periods; as an operator planning this mission, I can say, Phase 1 and Phase 2 are unacceptable. You will wear a dry suit. That's why, at least in our type of operations, I need the lowest, not necessarily the last, temperature found.

DR. WEINBERG: Do the operators want us to include all of the data, or would it be more useful to simply have core temperature, and if you will, a check box that would indicate this is likely to have impact on the mission performance? And if it is, then you can go back to the report and find out what that impact is. Do you want the broad data so that you can decide what they mean? Or would you prefer having some interpretation of the data that is based on the current state of knowledge?

CDR BUTLER: I appreciate everybody's comments on this. There is a terrific variety of opinions out there and I hope we've heard most of them.

Now, moving on to fingertip temperatures, it was my understanding that we were going to take that out. Basically we were more interested in hand performance for the operators. And that seems reasonable. The fingertip temperature is a little bit more esoteric and I think a little bit less easily understood by the operators than the core temperatures.

Moving on to the three subjective things we came away with. Is ease of donning something worth putting in here? I mean, given that swim trunks have one degree of ease, a wet suit has a second degree, a dry suit has a third degree, and a DATPS presumably will have a fourth degree. Is it worth trying to go beyond that? Everybody knows that this progressive increase of difficulty will be present. However, if there is a significant difference between dry suit A and dry suit B in terms of how easy it is to put on, that would be something that we would want to know.

LCDR KEITH: Also depends on the application. If your mission is to go in where you have to change clothes, donning and doffing in the middle of the operation is important.

You want to pick something that's going to give you equal thermal protection and is much easier to get on and off.

LT KAUFMAN: I personally don't feel it's necessary, because I know the gear that is being tested. There's more selection criteria as far as thermal factors that I'm concerned with.

CDR BUTLER: It's not knowing how to do it, the question is, is it easier or harder?

LT KAUFMAN: Well, I understand that, but I think I know the factors as far as getting dressed, taking my clothes off.

CDR BUTLER: Well, what if there were a new dry suit that you aren't familiar with that had some new features which made it easier to use.

LCDR WOOD: That's important because a DUI TLS dry suit was originally designed with zippers in front so one man could operate it. When we went to the Viking it has a zipper in the back that your swim buddy really needs to do for you. So, there is a significant factor in operational use that may be important.

MR. DUDINSKY: That's what I was going to say, how are you going to convey ease of donning? It seems pretty hard to do in a one-liner.

CDR BUTLER: Well, you know, you're right. Descriptive comments may require more than a one-liner.

MR. DUDINSKY: That's something we can read in the report. Like you're saying, have the one-page note any problems with donning. If the guys are interested they could go to the report and take a good look at it.

CDR BUTLER: Does the operator feel comfortable or does he not feel comfortable? Now, shall we break that down? Shall we also have a subjective for overall warmth, and look at hands separately? Or should we just use a performance measure for the hands?

UNKNOWN: Hands are important.

CDR BUTLER: So, we should look at subjective hand comfort as well? Shall we do the same thing for feet or just hands?

LCDR WOOD: You can walk on stubs.

CDR BUTLER: What about a measure of maneuverability? That's an awkward word, but what I'm trying to get around to saying is that if you put on this great big suit that has you looking like the Pillsbury Doughboy, it may keep you warm just great. And your

performance may be excellent if it's measured after you are out of the suit. But how are you going to approach the problem of the performance in the suit versus performance out of the suit. There at least needs to be some sort of input from the operators as to how easy it is to move around and perform a variety of tasks while still in the suit.

UNKNOWN: You'd have to have that.

LT KASEL: You know, I can move in it, but I got pretty cold. I was great but I couldn't move. Here are your two calls. If I'm just going to sit for 9 hours in the water I want to wear this one, but I need to move, so I'll need to take this one. You guys are going to be cold, but you're going to be functional.

CDR BUTLER: Is there a better word than maneuverability?

DR. GOFORTH: You're talking about suit performance. Equipment performance is more than just maneuverability. It could be that it flooded out. You're talking about one of several measures of equipment problems.

CDR BUTLER: Thank you for reminding me about equipment aborts.

LCDR WOOD: Well, equipment performance; it performs well, it fails.

UNKNOWN: Assuming it's all working. In some of your wet suits you can't even lift your arm.

LCDR WOOD: Well, it goes back to yesterday and maneuverability and durability being two different measures. Combat swimmers use wet suits because they're more maneuverable and they're probably a little colder than a person wearing a dry suit. They may also be wearing that same wet suit because it's more durable for their conditions.

CDR BUTLER: We won't be able to answer durability in these type of studies. Durability will have to come back from the teams.

CAPT THALMANN: Your maneuverability is important.

CDR BUTLER: Well, that's true. If we specifically did a study to go out and measure durability and simulated going through SEAL activities for X number of operations with this suit, then, yes, you could incorporate durability, but that is not currently anticipated.

LT. HART: If you have four suits and three of them fail and one works great, you know which is best.

CDR BUTLER: That's right and that's why we should have some quantification of

thermal garment failures. Let's say that we had eight runs, and we had five equipment aborts. No matter how warm it keeps you when it works, there is a problem with this dry suit. Why is it failing five out of eight runs? Well, that's a key measure and something that the operators, I think, are going to want to know.

Okay. So, is maneuverability the right word?

OSCM JARVIS: In some context it is like combat swimming.

LT HART: Don't you want to be a spreader here more than a lumper in these? Because you're going to worry about maneuverability. You've got concerns about manual dexterity, which is hand maneuverability.

CDR BUTLER: Good point. Why don't we break it down to maneuverability, total body and manual dexterity in the suit?

LCDR WOOD: Durability would make the operator decide to use or not to use a particular suit. The British use a dry suit and they pack themselves with thermal protection and they look like the Pillsbury Doughboy. You SDVers don't use all that insulation. Combat swimmers don't even use dry suits. It's all based on how much their mission requires them to be maneuverable. I think it's one of the most important factors.

CDR BUTLER: Right, and we're leaving it in there. So, we have ease of donning, total degree of warmth, degree of warmth with respect to the hands, manual dexterity of the suit, and maneuverability of the suit. Those are the five subjective factors. Now Drs. Doubt and Goforth will have to sit down and figure out some way to come up with a scale that will be as reproducible as we can make it for the guys to answer when they come off the operation.

UNKNOWN: Frank, you've assumed, though, that the suit defines what you wear on your hands.

CDR BUTLER: I think that diver dress absolutely has to encompass all factors of what the diver has on. It has to encompass his hood, it has to encompass his total suit configuration to include his gloves. Whatever kind of gloves he's got on have to be described under diver dress.

UNKNOWN: Hand dexterity is going to address what he's got on his hands, not what he's wearing on his body.

CAPT THALMANN: This thing is going to address what the report is about. Let's say the report is hand comfort evaluation and the diver was wearing a Viking dry suit. You don't read that report to find out how well a Viking dry suit works. You want to know how well these gloves work. So, the information here is obviously going to be targeted on what

the report is about. There may be some incidental stuff, like this Viking dry suit happened to leak. But you don't pick up a glove report to find out how the dry suit works.

CDR BUTLER: Let's say, for example, that Dr. Goforth is going to do a study where he looks at the divers in 62°F water. He goes out and measures these guys at the end of the study where they are using just wet-suit tops. Let's say that they are not wearing gloves so their hand maneuverability should not be affected. So, part of what we're doing here and what they'll have to work out in methodology is do we just put "not applicable?" Do we ask them to evaluate their hand maneuverability based on how cold they were or do we just say that we're going to measure their performance when they come out and we'll be able to answer to what kind of shape their hands are in on that performance?

CAPT THALMANN: The answer to everything is, yes. It depends on what the report is about.

CDR BUTLER: Well, let's go one step further. Let's say that the guys are wearing no rubber at all. It's 68°F water. Obviously maneuverability of the suit is not an issue, so you just write NA in there. Okay?

CAPT THALMANN: Yes.

CDR BUTLER: So, obviously these things are going to have to be applied with a little bit of flexibility to look at all these different situations.

LT KASEL: Let's say you put these guys in 58°F water to find out about gloves. We're also going to have this guy suited up in something to keep his body warm. Well, why not include all the information of what he was wearing? He was wearing a dry suit and the gloves worked great. He wasn't wearing a wet suit and the gloves worked okay.

CDR BUTLER: Diver dress has to include every aspect of what the diver had on. Because what you're saying is exactly right. The gloves are not an independent entity. They also relate to what the guy has on for his total body.

DR. GOFORTH: You said "the guy," and I'm not going to do studies with just one "guy." So, there is going to be a plethora of "the guys" wearing all kind of different stuff unless we control it. And that's not done unless the study design is the control.

CDR BUTLER: Give me an example.

DR. GOFORTH: Well, we monitor SDV guys in the field; and one guy is wearing the polypropolene, another has a Pattagonia, one is wearing cotton undergarment, and one guy has got a sweatshirt on. So, what is my one type of protective measurement? And yet, my data will show an average low core temperature for all the "guys." Say these two guys are average or got to 35°C.

CDR BUTLER: Well, I think that as an investigator you have to be able to decide what's a significant difference in diver's dress. And let me give you an example. If you have one guy in the SDV in a Phase 1/Phase 2 wet suit and the other guy in a dry suit, you need to fill out the divers dress differently; you have to fill out two of these sheets to reflect what both subjects did. But if the guy has on wet suit A versus wet suit B and they look about the same to you, they're both 3/8 inch. You may say, wet suit.

DR. GOFORTH: It comes back to what Dr. Thalmann said; it depends on the purpose of the study. And it seems that you're trying to make an overall form that covers everything. CAPT THALMANN: You're trying to direct too much. Let me give you an example of a report that was evaluating different thermal garments for the Royal Marines. The report was a comparison of different methods of thermal protection of hands and there were four different gloves that were used. You may present on one sheet how those four garments stacked up. You have some sort of presentation tc tell you whether garment A, B, C, or D was better. Then on another sheet of paper, how the four gloves stacked up. But the whole purpose of the study was to compare the dress.

So, it depends on what the report is about. If the report is about a specific type of suit, you might want to go into more detail. But there certainly are going to be a lot of equipment evaluations where the whole purpose of it is to compare different things. And there you would probably want them on one sheet so you could look at it and decide which was better.

CDR BUTLER: What you're saying is a good point. This would be a good time to stop and address that. Look at this vertical line, it's the one thing that goes back to what Brett was saying about the consumer report format. That's a great idea. However, if you, for example, on this line put suit A, suit B, suit C, suit D, and then just went through and used some sort of a numerical or pictorial code of how they performed, the one thing that I think that would be lost is that we would then not have a measure of how long they were exposed in that suit. In other words, we'd only be able to take the people who went for the entire exposure time. What about the people who only went for 2 hours as opposed to 8 hours?

LCDR WOOD: You could include that in your vertical list.

CDR BUTLER: You already have a vertical list based on the different items.

LCDR WOOD: Well, in other words, you have your list on the left, and then on the bottom you have "duration." And under "duration" you have 2, 4, 6, 8 hours. Then, you do you're little dots, your pictorial for each.

CAPT THALMANN: Here is an example. I don't know how many of you have read it, but it's a comparison of four dry suits and a wet suit and three different kinds of gloves. The idea is to take that whole report, which is 100 pages, and summarize it.

You start off with describing the environmental parameters. This is going to describe what the temperature of the water was and whatever the range was. What the exercise profile was, were these guys at rest or at exercise or were they doing something intermittent? Something about the individuals. You want to know if these guys were all fat or all skinny. So you put something down here about body fat. Age is probably not all that important. And the other things that you would put down are any manipulations. For instance, were these guys all charged up on caffeine or were they all taking a diuretic, or whatever?

The next part of this thing would be the ergonomics factors. Here's where we get to the garments, A, B, C, and D. And then down here we have some measures that we all agreed upon. What I've written down here is reliability. In other words, does the thing make it through the whole mission without failing? Things like range of motion, donning and doffing, manual dexterity, etc.

Here you could summarize all these things with a block dot and the open dot and the square. Whatever kind of symbols you wanted. So, you could look at this thing and decide how do A, B, C, and D compare.

The third thing you would want to put down is thermal status. You might want to divide that up into zero, one, two, three, etc. And on that you might plot the core temperature. So, for each garment you have a core temperature plot. You may want to plot something like an overall comfort index. Did the guys feel subjectively comfortable and how that changed with time.

Maybe down at the bottom you would have some measures of performance, whatever those are. You can divide it up into, say, psychomotor, cognitive, hand/eye. And it will give you some general idea of how performance degraded over time, because this stuff is all time sensitive. You could take something like that and distill it so you could look at this thing and you could decide whether Thinsulate was better than the Flectalon for your particular operation.

The problem you get into are these measures. What does reliability mean, is it average numbers of times that the mission was aborted because of an equipment problem. What does range of motion mean?

Ease of donning and doffing is going to be subjective, so you have to read the report. You would assume, at least for this report, that the investigator evaluated all of them the same. The problem you run into is whether a measure made at NMRI relates to a measure made at NHRC. That's where the investigators come in.

But what you've got here is the big three. The environmental factors, how was the study done? How was the environment influenced? The ergonomic factors: How did it fit? How did it feel? The hardware. Over time, how did these individuals perform?

CDR BUTLER: But you'd have to break this down into both the time scale and the other factors. You can do that the way that Mike Wood was suggesting, using the varying symbols for varying exposure times. I think that it has most of the same things that are here, and it has them broken down into a nice package.

CDR CURLEY: Full-time human factors people are employed to design the kind of format you're getting at. I think we have a good idea of the information we want and the precise methodology. The design and so forth can be assigned to certain individuals and worked out, and then coordinated through you to the teams for recommendation.

CDR BUTLER: Before we go on to other comments, are there any other things that the operators need to see on here or are there any things that they absolutely all want to have taken off here?

UNKNOWN: How about something that tells them directly what the insulation is?

CDR BUTLER: That's also a good point because it will help correlate with Dr. Thalmann's thermal garment selection study. Bear in mind that these studies will help Dr. Thalmann fine tune his thermal program, too. I mean, that's not a finished product; it will be modified as we get this kind of information back.

CAPT THALMANN: Let me tell you how the information was used in that particular report. In making the recommendations clo was not used. It was core temperature drop and performance and ergonomics. Those were the three factors that we cared about. Clo value was used only in coming up with a table of limits. So, the decisions on which garment they wanted to use had nothing to do with clo value.

LCDR WOOD: But a table of limits is important to us in prior planning, like, if we're going on board a submarine and we're very space limited.

CAPT THALMANN: What I'm telling you is that the actual clo value is not as important as the table of limitations. They don't care what the clo value was, they just wanted to know how long can they swim in this garment.

You can calculate clo value, but that's not useful information.

CDR BUTLER: It depends on the focus of your report. If you're wearing a dry suit with M600 or M400 Thinsulate, then you have a clo value. But if you're just talking about the evaluation of a dry suit, period, there is no one definite clo value. What you would get would be the clo value of whatever the configuration was as a total package.

DR. DOUBT: Frank, just to wrap this up with one comment and one suggested approach. The comment is, as I said earlier, that the researchers should not provide the operational impact. I make the converse suggestion that the operators should not decide what

the important measure is. They need a format.

My suggestion would be, if the operators were in agreement, that we come up with a mission scenario that says, for example, you have to go on a 6-hour operation that entails this water temperature, this activity level. We provide one or two sample format reports. Here's the information you got from the R&D community. Look it over, knowing that this is the operation you're supposed to go on, check off the things that were important in your decision-making process for doing it. We've got a lot of different ways of presenting this. If we keep on adding more information to this report it's soon going to get out of the one-page format.

CDR BUTLER: But it's still a one-page format now, right?

UNKNOWN: The titles are.

DR. DOUBT: Well, the titles are, but the information isn't.

CDR BUTLER: When you fill that up with information you would have to see.

DR. DOUBT: You've got garment up there as a one-liner.

CDR BUTLER: It may take three or four lines to define the garment.

DR. DOUBT: Going back to my suggestion, is that a reasonable approach to come away with from this workshop? That is, for the R&D community to put together a simulated one-page data sheet with dummy values? It's not a real study, just like it isn't a real mission. Send both of them out together. Once it gets to the teams we will know if it's useful and how they're going to use it. We can then refine MOD-0 there.

CDR BUTLER: Your thought is to go back and put that in a smooth copy, take it down to SEAL Team 2 and say, tell me if you can use this?

DR. DOUBT: No, send it to all the teams.

Take some format, however you want to put it together, with line information on it, one page. Limit it to one page and then simulate a mission scenario that says, for example, you've got to send four SEALS in to the beach in 50°F water. It's going to take you 3 hours to do that. You're going to be up there for 8 hours. You then rendezvous in 2 hours. That's the mission that your CO just gave you. R&D labs just gave you this one-sheet summary. Look at it and figure out how you would use this information to plan the operation.

LT KASEL: That's a good idea, but if you're going to do that you can't just give them one sheet. You'd have to give them multiple sheets representing their options.

DR. DOUBT: Sure, you give them three sheets of three different wet suit things on them. But then send it out and see whether in fact all of the teams use clo value, or whether the lowest temperature was important versus whether they atePpower Bars.

CDR BUTLER: I think that's a good idea. The one cautionary note that I would put in there is that you have to recall the First Law of Planning. That is, there is no big picture. In other words, you've had five or six guys with Budweisers here, who have been talking to you for a couple of days, and there has been a wide variety of opinions. If you send this out to a team that didn't have a representative you know what's going to happen to that. It's going to go to the newest guy who works in the Ward Room and the Captain is going to say, "Take care of this, Ensign."

UNKNOWN: That's where you come in. You're the roadplow for this.

CDR BUTLER: You're using a roadplow for a snowball for this. I would send your proposed format to the five people that you have here. And maybe ask them to take a few selected other team members and show it to them. But to try to bring in a bunch of people who at this point have no concept of what's going on, I think might obscure your desired results.

DR. DOUBT: Well, is that an agreeable approach, to send this to all the teams, or will some round file it?

CDR BUTLER: I don't think that anybody here is going to round file it.

LT KASEL: The more I think about it, if you've got the four wet suits, you only need one piece of paper. You send it to me and here's what wet suit A did. They have a black circle, which means very good. Wet suit B had a white circle which means I can go to 3 hours. I go down to the 3-hour column. It has got a black circle and I look around here and it's all white circles. I don't like that one. But here's one with half black, half white, and all the way through it's kind of what I'm looking for. I don't have to think hard. It's quick.

LT KAUFMAN: You were considering only sending it to teams that were represented here. I think if you sent it to the other teams and it's a good quality product, it's going to get the team's attention because it's going to do something for them. And it might even provide some fresh perspective that would be useful.

CDR BUTLER: I guess another way to say it is that I think that the input that he will get back from the five operators here is much more important than what he'll get back from somebody that was not involved in this. They won't understand what the thrust is.

LCDR WOOD: At least they've had the opportunity to respond, regardless of whether they had a quality response.

CDR BUTLER: I agree with that.

LCDR WOOD: And that would also determine how much weight you put on their response, whether they attended this workshop. If it does go to a team that didn't attend the workshop, but put a lot of time and effort into responding to the thing, then they've at least had an opportunity to get their input.

CDR BUTLER: Yes, that's true. And I may be wrong. There may be some of the teams that will give this to somebody who's hot, who can do a good job for us, so maybe we'll get some valuable information out of it.

LCDR WOOD: Your response to these would be directly related to the importance that that particular team puts on thermal issues. Regardless of whether they attended or not.

CDR BUTLER: And to what else is going on at the time and a million other things. But at least we'll have tried. It's just like inviting everybody to the conference; only five commands showed up, but at least everyone was invited.

CONCLUDING REMARKS

CDR CURLEY: This remaining session will provide a wrap-up for what we've covered the last 2 days and where we're going in the future.

As we gathered here yesterday morning we started out by having a brief which provided some common language on thermal stress and performance.

We then had seven SPECWAR representatives who gave us presentations on their mission, their tasks, and their equipment. They provided handouts, were very candid, and provided a lot of information for the R&D folks. I think I can say, as a representative of the R&D community, that many of us have a much better idea of what goes on in Special Warfare, what the risks are, and what the missions are. And this will help us in our planning of R&D and planning of studies to meet mission objectives.

We then discussed what information the operators required from the R&D community and we made a list of those items, which will be incorporated into this report.

The thermal session yesterday afternoon discussed standard measures for field and laboratory. We worked out conceptually, theoretically, and operationally some of the different avenues that we're going to take for measuring thermal measures.

The performance session identified key generic factors and abilities that are critical elements in global mission success across different scenarios. Our next step will be to get together in the R&D community and put proposed tests to the abilities which the operators

identified.

We had a data format session chaired by Captain Thalmann who identified the existing flow of medical R&D information, the need for a distribution list and avenues, the need for points of contact for R&D interpretation, and the types of data information conveyance that are required.

CDR Butler hosted our remaining issue session, and provided us with a list of SPECWAR-related reports, papers, and taskings. He proposed and outlined our future Biomedical Workshops to help us with our data presentation and the transference of knowledge from the R&D community to the operator, and identified the data required for reporting evaluations to users.

Dr. Doubt will let us know where we're going from here.

DR. DOUBT: The workshop has accomplished much. You may recall that yesterday we listed our expectations. We would not go away with any solutions, only approaches. Those approaches have been developed. They are in the fetal stage. They are not mature, they are not completely functional, but they are in a fetal stage.

I think we have agreed that the principal R&D labs will develop a format of R&D information, distribute it to the NSW units and commands for their feedback with simulated scenarios. That distribution and that first task provides subsequent guidance for exactly what we need. If you don't need diver's age, it goes away. If you do decide, operationally, that you need clo values, it gets incorporated. But we won't know that until we put it to the strawman test. That's the first follow-on.

The second follow-on is the published proceedings of this workshop. Once we receive the transcripts, CDR Curley and I will do the majority of the editing of it, focusing on what was said, what was presented, what was agreed upon, and, where necessary, revise the comments for clarity.

Those proceedings will ultimately be published as a report and distributed to all of the NSW commands and units, and all of the Naval R&D laboratories. Everyone will know what was said here, what was generally agreed upon as a start, and where we will go from here.

The third follow-on is to have updated workshops. We can't let this workshop die here. Too often we have meetings where we talk about things for a couple of days, and then go home. Well, it's not going to die here, in part, because proceedings are going to come out. In part, because an overview of this workshop will be presented at the NSW meeting in November. I've already talked to CDR Butler about subsequent follow-on workshops where we can look at the MOD-0 format, see what has changed in the operational requirements, see what has worked, what is in place and what is not in place. Three things are essential to the

workshop. One, there has to be operator input. Two, there has to be R&D input, and three, there needs to be coordination.

It is my personal opinion that follow-on workshops are essential. I don't know whether that's every year, every 2 years, or every 50 years. But if we don't review progress, my prediction is that this thermal effort will die. And that 5-10 years from now, when somebody new comes on the scene, they're going to say, "Gee, we ought to have a workshop and talk about standardized thermal issues." An old timer will say, "Wait a minute, I thought 5 or 10 years ago we did this."

But my point is, and it was brought out at this workshop, that we tend to recycle. To break out of that I think we need a follow-on workshop on a regular basis to look at what has been done, what needs to be revised, and what needs to continue.

There are the three follow-ons I see. One is that all the teams are going to get a MOD-0 format that says, "Read this and tell us how useful it was, if you actually had to do an operation or a training evolution."

Two, everybody's going to get the proceedings of what was said here and what was agreed upon.

Three, there are going to be follow-on actions in terms of keeping other people informed and looking at developing a continuation of the review process.

CDR BUTLER: I'd like to offer my thanks to Drs. Doubt and Curley for their professionalism and attention to detail in putting on what's turned out to be, I think, a very informative and useful session. I'd also like to express my appreciation for their ability to overcome their usual reticence to speak their minds very bluntly and forthrightly and putting their own opinions on the line here.

Also, I'm very appreciative of all the people who have taken time out from a lot of busy schedules to come and help us out with this. So, thanks and have a safe trip home.

CDR CURLEY: If you think we should do this again, let CDR Butler or Dr. Doubt know. If you didn't like the way it was run or if you have some constructive criticisms give them to CDR Butler or Dr. Doubt. I was very impressed, on a personal note, with the professionalism of all the team representatives who attended. It spoke very well for you and for your commands.

DR. DOUBT: I would amplify that comment. Of all the NSW meetings that I've been to over the past 6 or 8 years, this is really the first meeting where I've seen the operators given the general opportunity for input, and the opportunity to develop a dialogue. At the beginning, I said, "Everybody's opinion is respected." So often in many of these R&D meetings or NSW meetings the higher echelons come and talk, but most of the people

down in the trenches don't get a chance to provide input. Everyone that was here has made a significant contribution. I am particularly appreciative of the units that came here and provided us with the operators' input, without whom none of this would have worked.

CHAIRMAN'S SUMMARY

Attending the 1991 Naval Special Warfare Thermal Workshop were representatives from operating SEAL and SDV Forces, HQ, Development and Training Commands, and Navy Biomedical R&D activities. The goals of this workshop were outlined by Dr. Doubt of NAVMEDRSCHINST and CDR Butler of NAVSPECWARCOM during the first hour: 1) to establish standard sets of thermal and performance data to be collected by both operational and research personnel; 2) to develop an optimal reporting format for communication among NSW operational and research activities.

Setting the stage for future sessions, CDR Curley of NAVMEDRSCHINST established a common baseline for all participants by presenting an overview of physiological and performance alterations that arise from thermal stress.

Immediately afterwards, representatives of NSW Groups 1 & 2, SEAL teams 3, 4, 5, and 8, SDV Team 1, NSW Development Group, and NSW Training Center presented a series of briefs, describing each NSW activity's mission and operating environment. These briefings identified real-world problems associated with thermal stress. From these presentations, common concerns surfaced and centered on information-sharing among teams, test and evaluation procedures for thermal protection garments, reporting of results post-operation, documentation and distribution of lessons learned, and dissemination of biomedical research with practical, understandable reporting to SEAL operational forces. Information the operators required from the medical R&D community was also outlined.

Drs. Doubt and Goforth chaired a lively session on thermal measurements. The requirements and rationales for capturing specific demographic, physiological, and mission event data were discussed. Specific measures, problems in obtaining these measures, and their relevancy to operation decisions were also explored. Out of this session specific recommendations for thermal measures to be used in the field and laboratory will be forthcoming from the biomedical scientists. These recommended measures will be circulated to operators for comment and validation. Problems associated with the formatting of reports and measurements were also addressed.

During a focused session on mission performance led by CDR Curley and Dr. Thomas, participants identified cognitive, psychomotor, and physical performance tasks that are likely to be "mission stoppers." These critical tasks were documented, along with the underlying abilities associated with performance of each task. Follow-on meetings from this session will functionally group the underlying abilities, estimate their importance, and assign each a weighting. This listing of critical performance abilities will be sent for comment to the operating forces. After validation by the operating forces, behavioral scientists will recommend tests and measures of the most important abilities for inclusion at all medical R&D institutions conducting SPECWAR research.

The second day of the conference began with a session on data formatting and reporting, led by CAPT Thalmann. Starting with an explanation of how the data flow among the various operational and R&D activities, CAPT Thalmann led the group in exploring the difficulties and pitfalls of transitioning recommended solutions into operational products. Defining the end use of the information is critical. The issues of who decides on whether the products will be used, and the adequacy of the existing decision-making process were raised. Lay language summaries and a central coordinator for the distribution of reports were observed to be essential to the success of the thermal program.

The final session on remaining issues was chaired by CDR Butler. Distribution of the first listing of available SPECWAR-related medical reports, papers, and taskings highlighted this session. In addition, recommendations for future biomedical workshops and training were outlined. A concerted effort was made to identify the essential data and format for a single-page thermal evaluation document. This document will be completed by operators after each mission/exercise and forwarded to the research facilities. The document will be developed by the R&D institutions and given to the operators for their feedback.

Follow-on action items include:

-publication of proposed standard thermal measures (Drs. Doubt & Goforth)

-publication of proposed standard performance measures (CDR Curley & Dr. Thomas)

-coordination of future thermal conferences (CDR Butler)

-distribution list for reports and documents (CDR Butler)

-thermal evaluation format (Dr. Doubt & CDR Butler)

ANNEX A
WORKSHOP ATTENDEES

COMMAND	REPRESENTATIVE(S)
NAVSPECWARCOM	Frank Butler, CDR, MC Cal Polland, CDR, MC Frank Wattenbarger, Code 006
NAVSEA 06-Z	Frank Lauria, LCDR
NAVSEA OOC	Jim Ruth, OOC-035
NSW GROUP 1	John Dudinsky, Code N8
NSW GROUP 2	W. B. Austin, BMCM Charles Baker, HM1
SEAL TEAM 3	Joe Pappamihiel, HM2
SEAL TEAM 4	Mark Kasel, LT(jg)
SEAL TEAM 5	David Kaufman, LT(jg)
SEAL TEAM 8	John Jarvis, OSCM
SDV TEAM 1	Mike Wood, LCDR
NSW DEVELOPMENT GROUP	Brett Hart, LT, MC
NSW TRAINING CENTER	Jim Keith, LCDR
NAVCOASTSYSCEN	Steve Fitzgibbon, Code 5320 Kevin Jermyn, Code 5110 Richard Roesch, Code 5410 Jim Rish, Ph.D. Jody Wood
NAVXDIVINGU	Paul Kelleher, LT, MC
NAVHEALRSCHCEN	Hal Goforth, Ph.D. Keith Prusaczyk, Ph.D.

NAVMEDRSCHINST	Mike Curley, CDR, MSC Tom Doubt, Ph.D. Dale Hyde, Ph.D. John Schrot, Ph.D. Ed Thalmann, CAPT, MC John Thomas, Ph.D. Bob Weinberg, Ph.D.
TRANSCRIPTIONIST	Elaine Ferguson American Federal Reporting Services

APPENDIX B

STANDARD THERMAL INDICES

The Thermal Session, chaired by Drs. Doubt and Goforth, discussed a variety of objective and subjective measures of thermal stress.

Several salient points emerged during this session. First, the R&D laboratories would not be restricted to measuring only the standard indices; they can make additional measurements as deemed necessary. Second, any measure, *per se*, needs to be interpreted with respect to information that is useful to mission planners. It is also very important to tie thermal measures into performance measures. The performance measures are presented in Annex C. It was recognized that integration of thermal and performance measures will require additional research to validate their effectiveness. Third, there was no uniform consensus on the best way to include all the vital information on a one-page summary. This issue was discussed at length in the Data Format Session.

The following three sections present indices that, in the opinion of the Session chairs, represent a good starting point for standardization of thermal measures. It is recommended that they be incorporated into NSW R&D research plans. The actual measurement techniques will be developed and modified by research laboratories as more experience is gained in their use. The measures themselves, though, can begin immediately since they will contribute to the standardization of research efforts.

OBJECTIVE MEASURES:

-number of subjects in study

-age of subjects

-body composition (% body fat or body type)

-type of dive experience (military, civilian, SEAL, etc.)

-recent exposure to cold (acclimitization, etc.)

-type of study (whether lab or field study)

-air and water temperature

-exposure time and profile (wet-dry-wet transitions, etc.)

-thermal protection garment (type, undergarments, etc.)

-aborts or other failures encountered (number, type)

THERMAL MEASURES:

-finger and toe temperature (when possible)

-limb temperature (when doing performance tests)

-core temperature (specify site)

SUBJECTIVE MEASURES:

-shivering (present/absent, relative magnitude)

-thermal comfort (perceived thermal sensation, comments)

APPENDIX C

STANDARD PERFORMANCE INDICES

The afternoon performance session co-chaired by Dr. Thomas and CDR Curley yielded a wealth of information. We summarized this knowledge from the flip chart and notations made during the session, which reflected the responses of the audience to the following question:

"What are the most critical behaviors likely to affect the success of the mission?; i.e. those behaviors most likely to be mission stoppers?"

The following three areas represent, in the opinion of the session chairs, standardized behaviors and tasks that can be incorporated into R&D research projects. One or more of the measures in each area should be used, when appropriate, in NSW research studies. It is understood that these measures may be modified in out-years as new information is acquired.

CRITICAL COGNITIVE BEHAVIORS

-attention

-memory (short and long-term)

-logical reasoning

-vigilance, attention, concentration, altertness

-reaction time (simple and complex)

-orientation, relational comparison, conceptualization

-sequential ordering

-calculations

CRITICAL PSYCHOMOTOR BEHAVIORS

-eye-hand coordination (e.g. 3D tracking task)

-depth perception

-fine motor control (e.g. in performing medical procedures)

-finger and manual dexterity

-tracking

-sensory input (visual and verbal)

CRITICAL PHYSICAL TASKS

-strength

*finger
*hand
*arm
*grip
*leg
*whole body

-endurance

-balance and equilibrium

-limb and whole body coordination

-climbing